09/426156 09/30/98

701	14
Class	Subclass

ISSUE CLASSIFICATION

[redacted]

PATENT NUMBER
6181990
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U.S. UTILITY PATENT APPLICATION

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PATENT DATE JAN 3 0 2001

SECTOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
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PREPARED AND APPROVED FOR ISSUE

ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)						
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
701	14	701	35					
INTERNATIONAL CLASSIFICATION		455	431					
H04B	7/00							
G06F	17/40							
G06F	13/00							
	/							
	/					☐ Continued on Issue Slip Inside File Jacket		

☐ TERMINAL DISCLAIMER	DRAWINGS			CLAIMS ALLOWED	
	Sheets Drwg.	Figs. Drwg.	Print Fig.	Total Claims	Print Claim for O.G.
	10	11	2	33	1

☐ a) The term of this patent subsequent to __________ (date) has been disclaimed.

(Assistant Examiner) 9/23/00 (Date)

NOTICE OF ALLOWANCE MAILED
8-29-00

☐ b) The term of this patent shall not extend beyond the expiration date of U.S Patent. No. __________

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TECHNOLOGY CENTER 3600
(Primary Examiner) 8/25/00 (Date)

ISSUE FEE

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$1210	12/01/00

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R44

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ISSUE FEE IN FILE

Drawings L (LABEL AREA)

Drawings (___shts) set___

(FACE)

EFS 11/2/00

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/126,156	07/30/98	~~364~~ 701	~~2786~~ 3661	TET-1689

APPLICANT: JOHN FRANCIS GRABOWSKY, CAMARILLO, CA; DAVID RAY STEVENS, SIMI VALLEY, CA.

CONTINUING DOMESTIC DATA******** none
VERIFIED

371 (NAT'L STAGE) DATA******** none
VERIFIED

FOREIGN APPLICATIONS******** none
VERIFIED

FOREIGN FILING LICENSE GRANTED 08/13/98

Foreign Priority claimed 35 USC 119 (a-d) conditions met	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐yes ☒no ☐yes ☒no ☐Met after Allowance Verified and Acknowledged _____ Examiner's Initials _____ Initials	CA	11	33	7

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TITLE: AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM

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$1,404		

PATENT APPLICATION

09126156

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CONTENTS

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1.	Application Papers papers.		42.		
2.	[illegible]	7-30-98	43.		
9/29 3.	Rej 3 mo	10-1-99	44.		
4.	IDS w/Atch	11/12/99	45.		
5.	Amdt A	12/30/99	46.		
6.	Ltr to Drafts.	12/30/99	47.		
7/4 7.	Rej 3 mos	02-09-00	48.		
8.	Assoc PA	7-6-00	49.		
9.	Interview Summary	7-6-00	50.		
10.	Ext. of time 2m (c/m 7-10-00)	7-10-00	51.		
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13.	Notice of Allowability	8-29-00	54.		
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US006181990B1

(12) **United States Patent**
Grabowsky et al.

(10) **Patent No.: US 6,181,990 B1**
(45) **Date of Patent: Jan. 30, 2001**

(54) **AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM**

(75) Inventors: **John Francis Grabowsky**, Camarillo; **David Ray Stevens**, Simi Valley, both of CA (US)

(73) Assignee: **Teledyne Technologies, Inc.**, Los Angeles, CA (US)

(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: 09/126,156

(22) Filed: **Jul. 30, 1998**

(51) Int. Cl.[7] H04B 7/00; G06F 17/40; G06F 13/00

(52) U.S. Cl. 701/14; 701/35; 455/431

(58) Field of Search 701/14, 3, 24, 701/35; 455/431, 422, 456

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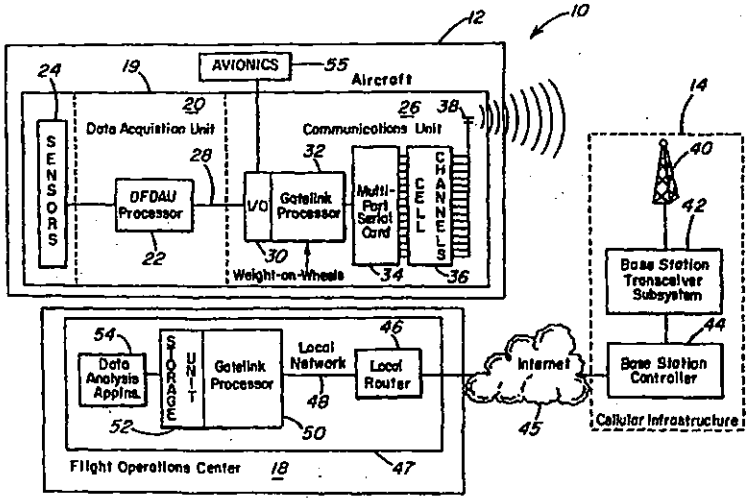
Primary Examiner—William A. Cuchlinski, Jr.
Assistant Examiner—Eric M Gibson
(74) *Attorney, Agent, or Firm*—Kirkpatrick & Lockhart LLP

(57) **ABSTRACT**

An aircraft data transmission system used with an aircraft having a data acquisition unit. The system includes a communications unit located in the aircraft and in communication with the data acquisition unit. The system also includes a cellular infrastructure in communication with the data communications unit after the aircraft has landed. The system further includes a data reception unit in communication with the cellular infrastructure.

33 Claims, 10 Drawing Sheets



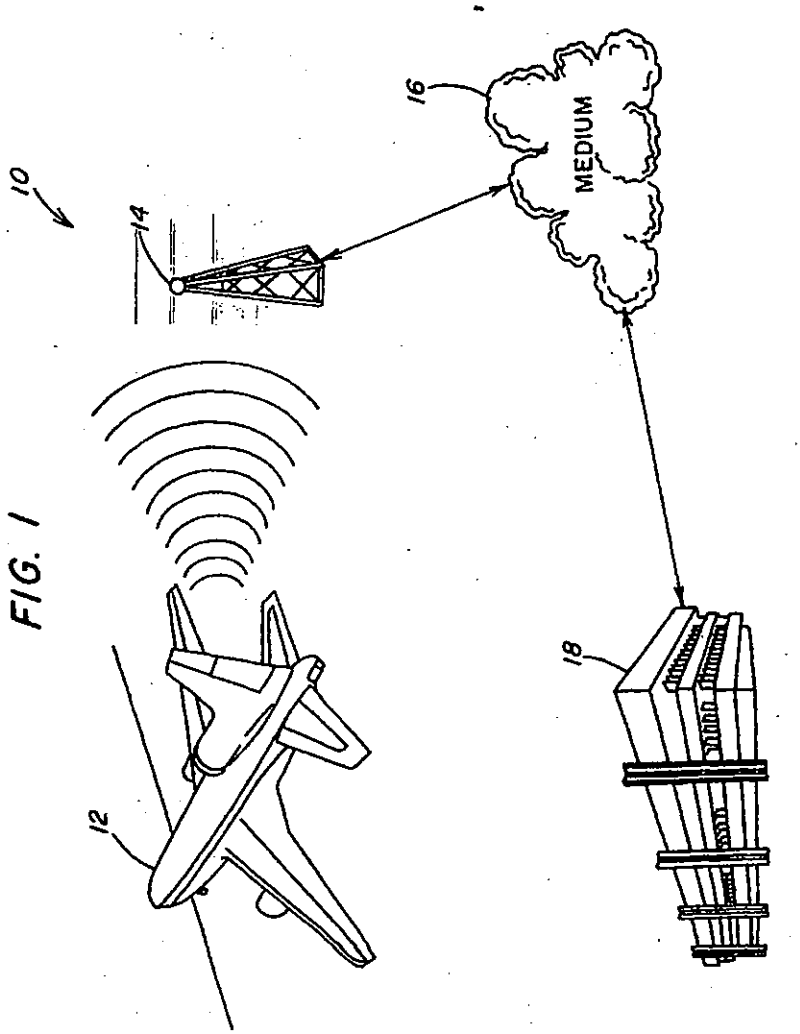
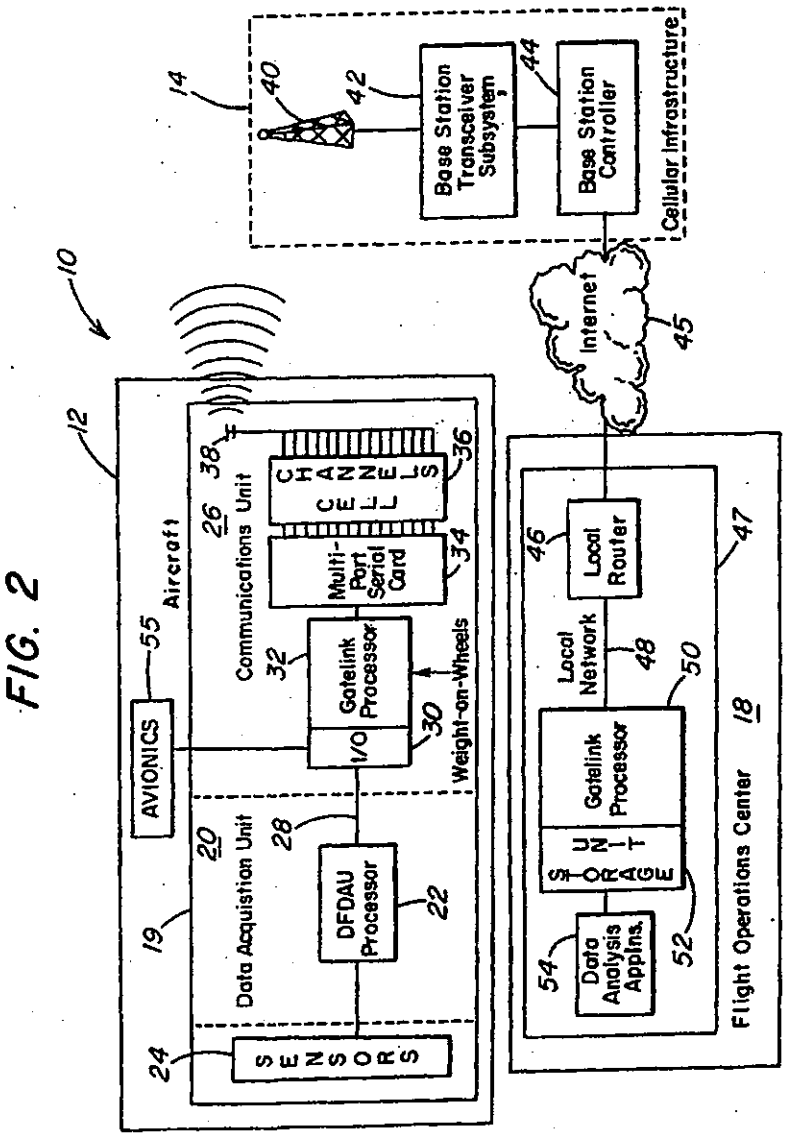


FIG. 1

FIG. 2


Cellular Infrastructure
Base Station Transceiver Subsystem
Base Station Controller
Internet
Aircraft
Communications Unit
CHANNEL CELLS
Multi-Port Serial Card
Gatelink Processor
I/O
Weight-on-Wheels
AVIONICS
Data Acquisition Unit
DFDAU Processor
SENSORS
Flight Operations Center
Local Router
Local Network
Gatelink Processor
STORAGE UNIT
Data Analysis Applns.

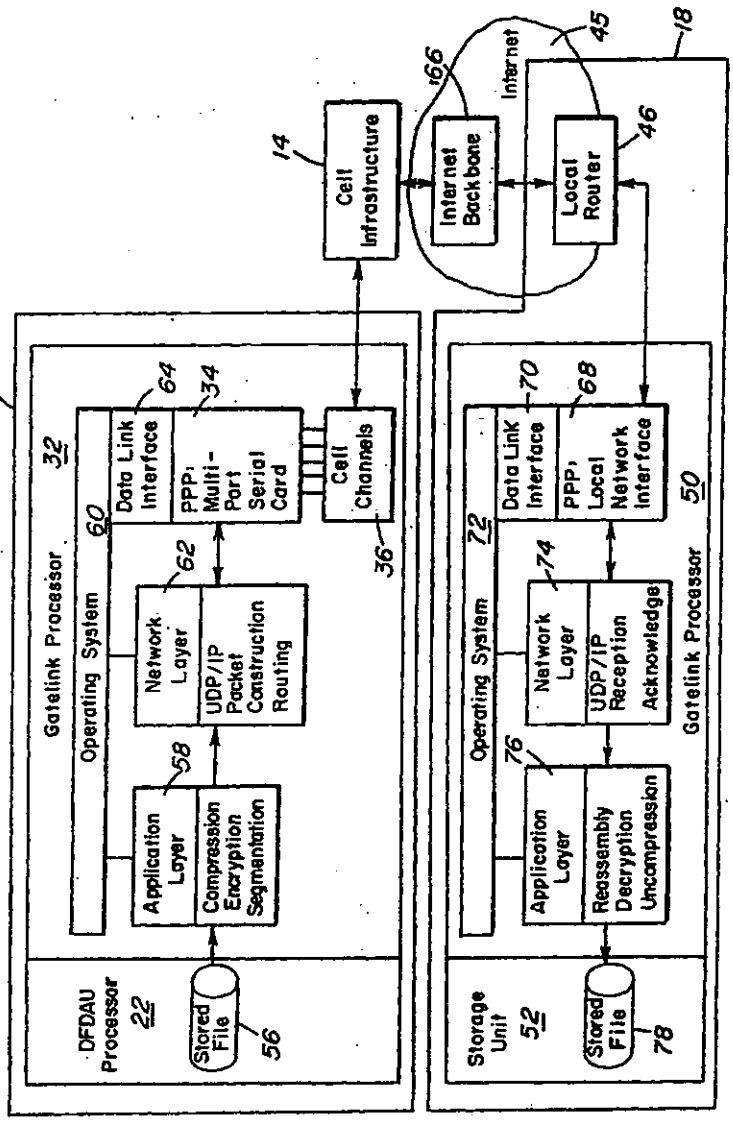

12
Gatelink Processor
Operating System
32
60
Data Link Interface
64
PPP, Multi-Port Serial Card
34
Cell Channels
36
Network Layer
62
UDP/IP Packet Construction Routing
Application Layer
58
Compression Encryption Segmentation
DFDAU Processor
22
Stored File
56
14
Cell Infrastructure
166
Internet Backbone
Internet
45
18
Local Router
46
Gatelink Processor
Operating System
72
Data Link Interface
70
PPP, Local Network Interface
68
50
Network Layer
74
UDP/IP Reception Acknowledge
Application Layer
76
Reassembly Decryption Uncompression
Storage Unit
52
Stored File
78

FIG. 3

FIG. 4

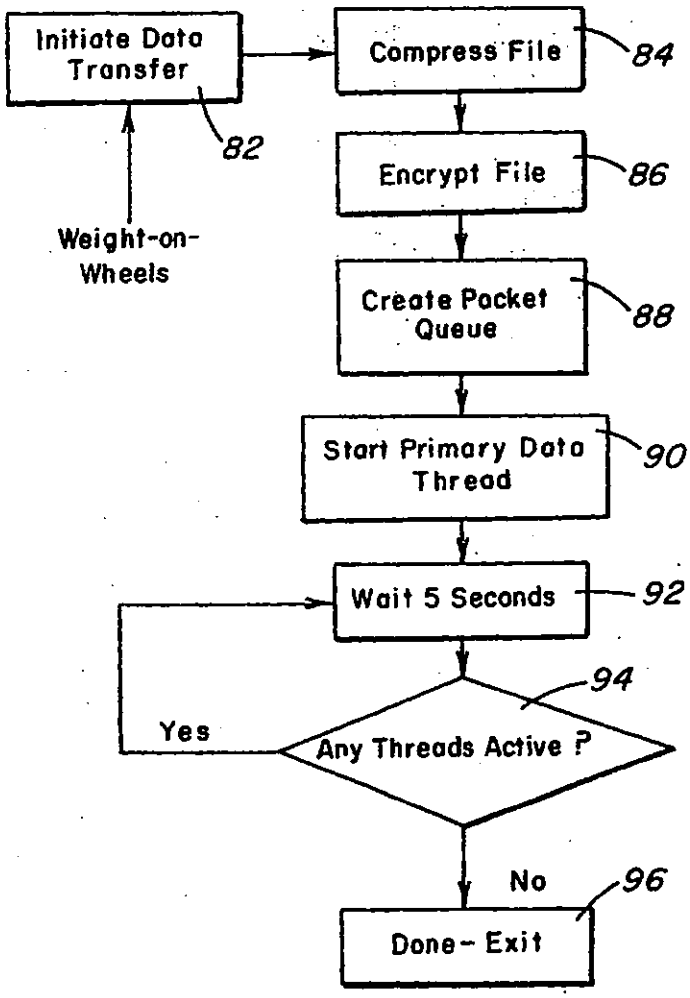

Initiate Data Transfer
82
Weight-on-Wheels
Compress File
84
Encrypt File
86
Create Packet Queue
88
Start Primary Data Thread
90
Wait 5 Seconds
92
94
Yes
Any Threads Active ?
No
96
Done - Exit

FIG. 5

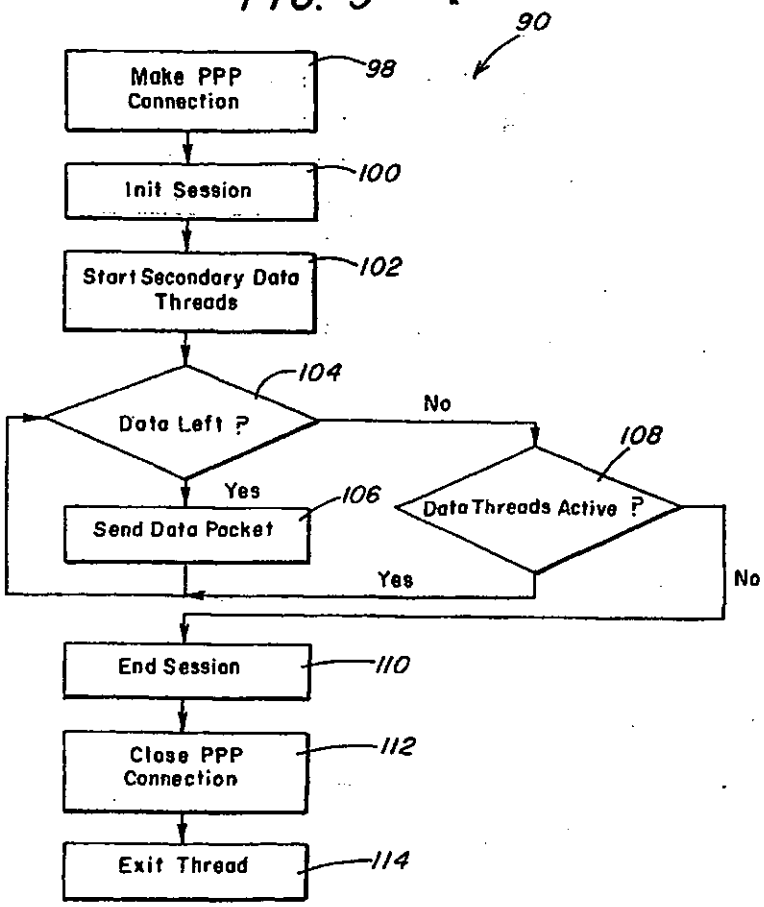

90
Make PPP Connection
98
Init Session
100
Start Secondary Data Threads
102
Data Left ?
104
No
Yes
Send Data Packet
106
Data Threads Active ?
108
Yes
No
End Session
110
Close PPP Connection
112
Exit Thread
114

FIG. 6

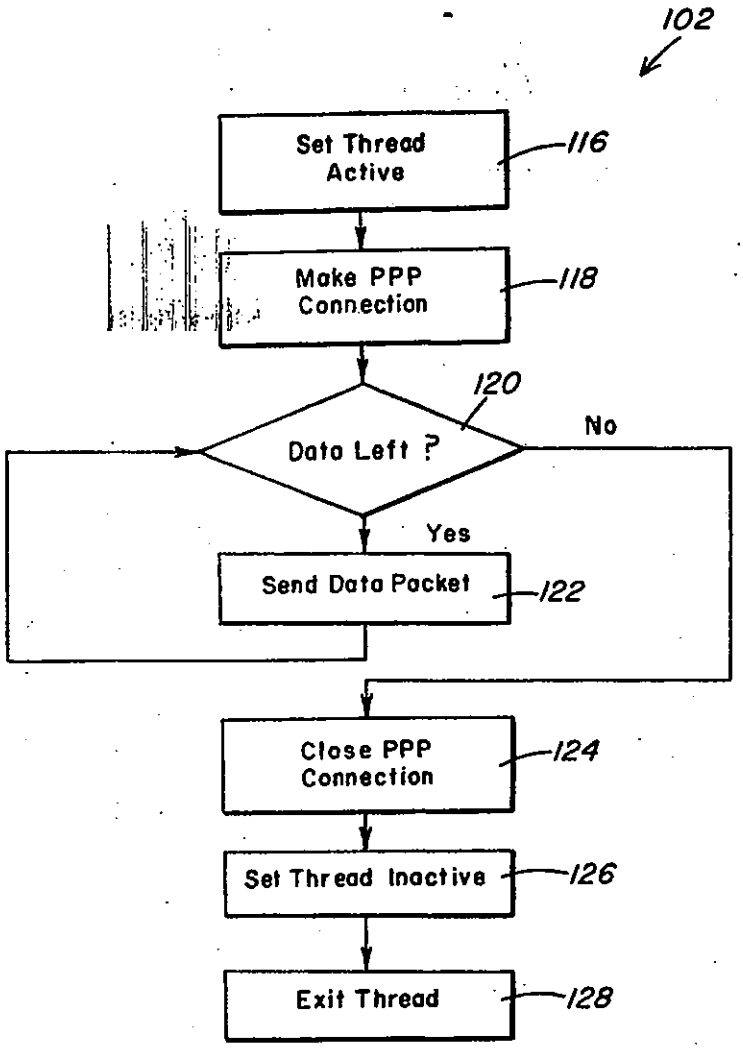

102
Set Thread Active
116
Make PPP Connection
118
120
Data Left ?
No
Yes
Send Data Packet
122
Close PPP Connection
124
Set Thread Inactive
126
Exit Thread
128

FIG. 7

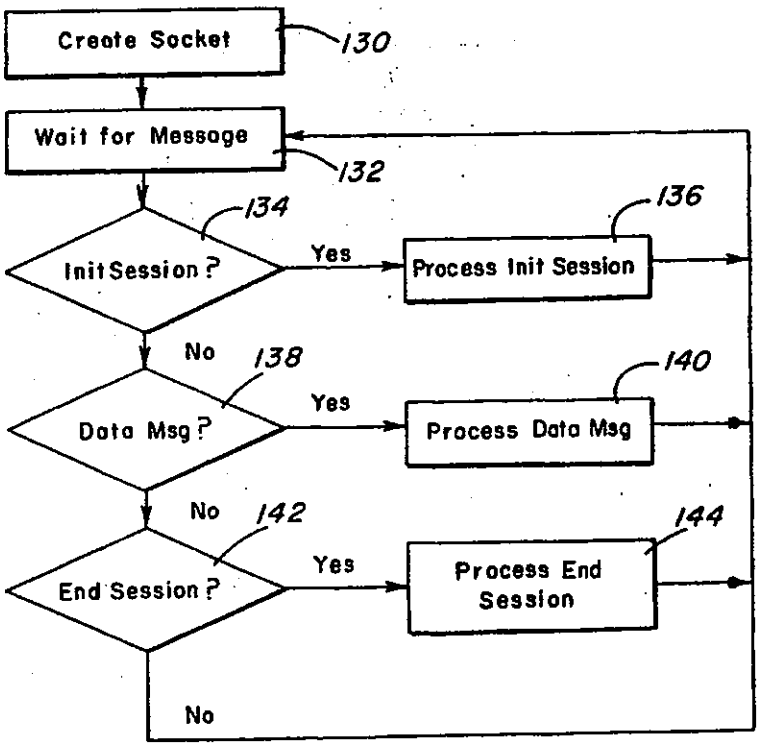

Create Socket
130
Wait for Message
132
134
Init Session ?
Yes
136
Process Init Session
No
138
Data Msg ?
Yes
140
Process Data Msg
No
142
End Session ?
Yes
144
Process End Session
No

FIG. 8

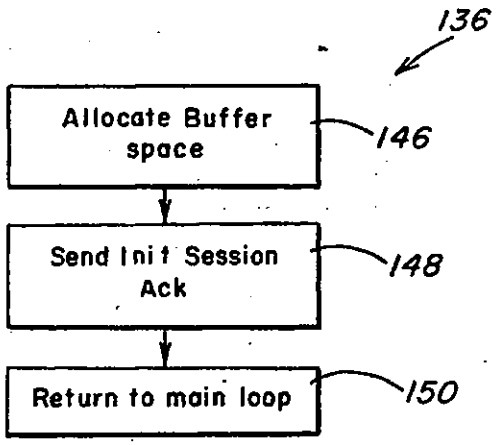

136
Allocate Buffer space
146
Send Init Session Ack
148
Return to main loop
150

FIG. 9

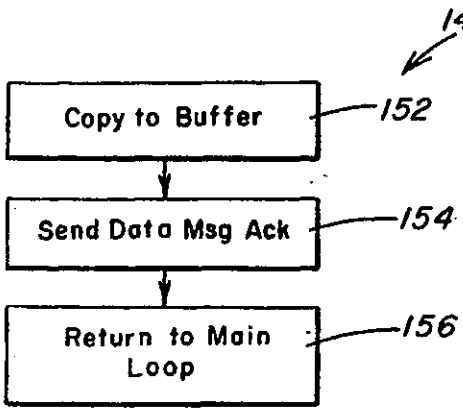
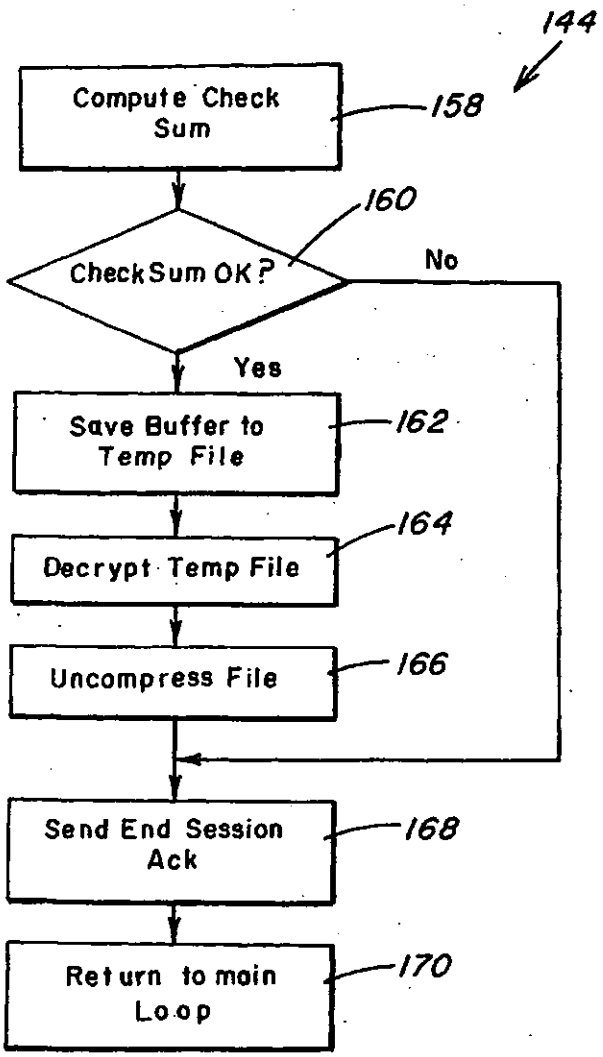

140
Copy to Buffer
152
Send Data Msg Ack
154
Return to Main Loop
156

FIG. 10


144
Compute Check Sum
158
160
CheckSum OK?
No
Yes
Save Buffer to Temp File
162
Decrypt Temp File
164
Uncompress File
166
Send End Session Ack
168
Return to main Loop
170

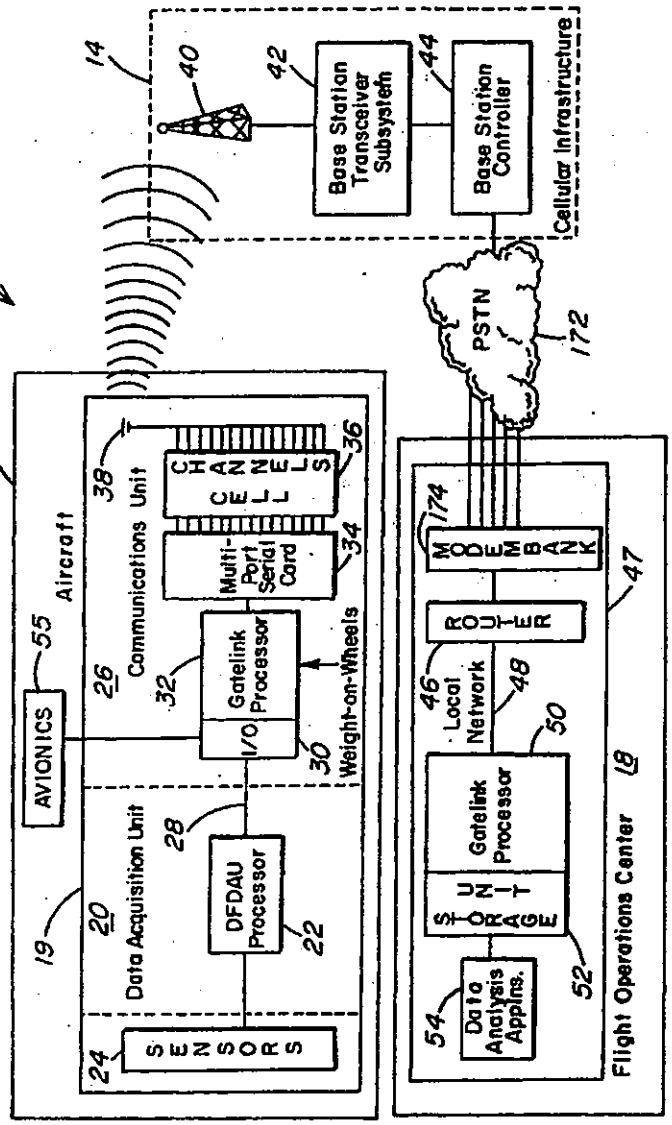

Cellular Infrastructure
Base Station Transceiver Subsystem
Base Station Controller
PSTN
Aircraft
Communications Unit
CHANNELS
Multi-Port Serial Card
Gatelink Processor
I/O
AVIONICS
Weight-on-Wheels
Data Acquisition Unit
DFDAU Processor
SENSORS
MODEM BANK
ROUTER
Local Network
Gatelink Processor
STORAGE UNIT
Data Analysis Applns.
Flight Operations Center

FIG. 11

AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

(Not Applicable)

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

(Not Applicable)

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed generally to an aircraft flight data acquisition and transmission system and, more particularly, to an on-board cellular data transmission system.

2. Description of the Background

It is common for aircraft to generate records of data relating to flight and performance parameters for each flight of the aircraft. The data typically relate to parameters such as air speed, altitude, vertical acceleration, heading, time, etc. The data are utilized in the event of an accident or a near-accident and to assist in maintenance of the aircraft by detecting faulty components or gradual deterioration of a system or component, to assist in reviewing crew performance, and to assist in logistical planning activities such as scheduling and routing.

Aircraft data are typically gathered by a digital flight data acquisition unit (DFDAU). The DFDAU typically stores the data on magnetic or magnetic-optical media. When the aircraft lands, ground personnel board the aircraft, remove the media, and mail the media to a flight operations center (FOC). The manual removal and posting of the data adds a significant labor cost, yields less than desirable data delivery reliability, and results in a significant time delay before the data are useful for analysis.

It is known to use radio frequency (RF) transmissions to transmit data relating to an aircraft. Such teachings, however, require substantial investments to construct the RF transmission systems required for such a system to work. Furthermore, it is very expensive to create redundancy in such a system.

It is also known to transmit data relating to an aircraft via a telephone system located in a terminal. Such a system, however, requires that the aircraft be docked at the gate before transmission begins, thereby resulting in a substantial delay in the transmission. Furthermore, such a system requires an added step of transmitting the data from the aircraft to the terminal telephone system, increasing the cost of installing, operating, and maintaining such a system.

Thus, there is a need for an aircraft data transmission system that automatically transfers flight data from an aircraft to a flight operations center with little or no human involvement and which relies on a reliable wireless delivery system.

SUMMARY OF THE INVENTION

The present invention is directed to an aircraft data transmission system used with an aircraft having a data acquisition unit. The system includes a communications unit located in the aircraft and in communication with the data acquisition unit. The system also includes a cellular infrastructure in communication with the data communications unit after the aircraft has landed. The system further includes a data reception unit in communication with the cellular infrastructure.

The present invention represents a substantial advance over prior aircraft data acquisition and transmission systems. For example, the present invention has the advantage that it requires little expense to implement because it uses well-known technology and the cellular infrastructure which is already in place. The present invention also has the advantage that it can transmit data over multiple parallel channels to achieve the necessary transmission bandwidth and achieve a low data transmission time. The present invention has the further advantage that it does not require a dedicated data link between the aircraft and the flight operations center and/or an airport terminal.

BRIEF DESCRIPTION OF THE DRAWING

For the present invention to be clearly understood and readily practiced, the present invention will be described in conjunction with the following figures, wherein:

FIG. 1 illustrates an aircraft data acquisition and transmission system;

FIG. 2 is a block diagram illustrating a more detailed embodiment of the system illustrated in FIG. 1;

FIG. 3 is a block diagram illustrating data flow through the system illustrated in FIG. 2;

FIG. 4 is a flowchart illustrating a method carried out by the gatelink processor in the aircraft;

FIG. 5 is a flowchart illustrating a method of performing the start primary data thread step of FIG. 4;

FIG. 6 is a flowchart illustrating a method of performing the start secondary data threads step of FIG. 5;

FIG. 7 is a flowchart illustrating a method of operating the gatelink processor in the flight operations center;

FIG. 8 is a flowchart illustrating a method of performing the initialize session process step of FIG. 7;

FIG. 9 is a flowchart illustrating a method of performing the data message process step of FIG. 7;

FIG. 10 is a flowchart illustrating a method of performing the end session process step of FIG. 7; and

FIG. 11 is a block diagram illustrating another embodiment of the system illustrated in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

It is to be understood that the figures and descriptions of the present invention have been simplified to illustrate elements that are relevant for a clear understanding of the present invention, while eliminating, for purposes of clarity, other elements found in a typical communications system. It can be recognized that other elements are desirable and/or required to implement a device incorporating the present invention. For example, the details of the cellular communications infrastructure, the Internet, and the public-switched telephone network are not disclosed. However, because such elements are well known in the art, and because they do not facilitate a better understanding of the present invention, a discussion of such elements is not provided herein.

FIG. 1 illustrates an aircraft data acquisition and transmission system 10. An aircraft 12, which has stored flight data, is illustrated after landing. The aircraft 12 transmits flight data as cellular communications signals to a cellular infrastructure 14. The cellular infrastructure 14 acts as a

communications channel to the communications medium 16. A flight operations center 18 is connected to the medium 16 by any conventional connectivity medium such as, for example, a leased line. Once the cellular connections are made via the medium 16 data can flow bidirectionally from or to the aircraft.

FIG. 2 is a block diagram illustrating a more detailed embodiment of the system 10 illustrated in FIG. 1. The aircraft 12 includes a data system 19 having a data acquisition unit 20. The data acquisition unit 20 includes a digital flight data acquisition unit (DFDAU) processor 22, which includes a storage media for storing flight data in a digital format. The DFDAU processor 22 receives signals from sensors 24 which sense parameters such as air speed, altitude, vertical acceleration, heading, time, etc. The flight data are transferred to a communications unit 26 via a bus 28. The bus 28 is connected to an I/O interface 30 in the communications unit 26. The I/O interface 30 can be a standard bus interface such as, for example, an ARINC 429 bus interface.

The I/O interface 30 is connected to a gatelink processor 32. The processor 32 can be a general purpose processor such as a personal computer, a microprocessor such as an Intel Pentium® processor, or a special purpose processor such as an application specific integrated circuit (ASIC) designed to operate in the system 10. The processor 32 is responsive to a weight-on-wheels signal, which acts as an interrupt signal to signal the processor 32 to initiate transmission or reception of the data when the aircraft 12 has landed. Upon receipt of the weight-on-wheels signal from the landing gear of the aircraft 12, the processor 32 prepares the flight data for transmission and transmits the data to a multi-port serial card 34. Each I/O port of the card 34 is attached to a cell channel which can open, sustain, and close a physical, over-the-air channel to the cellular infrastructure 14. The cell channels 36 can transmit simultaneously and can thus transmit data in parallel. Each cell channel 36 is connected to an antenna matching network and a post amplifier (not shown). An antenna 38 is installed in the aircraft 12 so as to optimize free space radiation to the cellular infrastructure 14.

The data are transmitted over a cellular airlink using the physical layer modulation of the cellular infrastructure 14. The cellular infrastructure 14 includes an antenna 40, which is within free-space radiating range of the aircraft 12. The antenna 40 is connected to a base station transceiver subsystem 42. The subsystem 42 is connected to a base station controller 44 which has a direct connection via a router (not shown) to the Internet 45. The flight data are transmitted via the Internet 45 to the flight operations center 18.

A local router 46 in a data reception unit 47 of the flight operations center 18 is connected to the Internet 45, such as via a connection to the backbone of the Internet 45. The router 46 connects a local area network 48 to the Internet 45. The local area network can be of any type of network such as, for example, a token ring network, an ATM network, or an Ethernet network. A gatelink processor 50 is connected to the network 48 and receives the flight data for storage in an attached storage unit 52. The storage unit 52 can be any type of unit capable of storing data such as, for example, a disk array or a tape drive. The storage unit 52 makes the flight data available to data analysis applications 54 which can analyze and/or report the flight data to a user.

Data transfer can also occur from the flight operations center 18 to the aircraft 12. The data are transmitted via the Internet 45 and the cellular infrastructure 14 and received by the antenna 38. The serial card 34 receives the data from the cell channels 36 and the processor 32 outputs the data, via the I/O interface 30, to avionics 55.

FIG. 3 is a block diagram illustrating data flow through the system 10 illustrated in FIG. 2. The flight data is stored in the DFDAU processor 22 as a stored file 56. An application layer 58 of an operating system 60 of the gatelink processor 32 compresses, encrypts, and segments the data. The operating system 60 can be any type of operating system suitable such as, for example, UNIX. A typical stored file may be compressed from approximately 40 Mbytes to approximately 4 Mbytes. Compression may be done by any compression method such as, for example, the method embodied in the PKZIP® compression utility, manufactured by PKWARE, Inc. Encryption can be accomplished using any suitable asymmetric (public key) or symmetric encryption method such as, for example, the method embodied in Data Encryption Software (DES), manufactured by American Software Engineering or the methods in the RC2, RC4, or RC5 encryption software manufactured by RSA Data Security, Inc. During segmentation individual datagrams of, for example, 1024 bytes are formed and indexed for subsequent reassembly.

The operating system 60 passes the datagrams to a network layer 62 which constructs UDP/IP packets from the datagrams by adding message headers to the datagrams. The network layer 62 then routes the packets to one of up to 16 peer-to-peer protocol (PPP) threads running within the operating system 60 at a data link layer interface 64. The PPP threads convey the packets to the multi-port serial card 34 for transmission to the backbone 66 of the Internet 45 via the cell channels 36 to the cellular infrastructure 14. The packets are received from the Internet 45 by the local router 46 in the flight operations center 18. The network layer 62 receives acknowledgments of received packets from the gatelink processor 50 in the flight operations center 18. The network layer 62 also requeues packets that are dropped before reaching the gatelink processor 50.

The local router 46 in the flight operations center 18 receives the packets and routes them to the gatelink processor 50. A local network interface 68 receives the packets and a data link layer interface 70 of an operating system 72 passes the packets to a network layer 74 of the operating system 72. The operating system 72 can be any type of suitable operating system such as, for example, UNIX. The network layer 74 sends acknowledgments of successful packet deliveries to the gatelink processor 32. The network layer 74 also removes the UDP/IP headers and passes the datagrams to an application layer 76. The application layer 76 reassembles, decrypts, and uncompresses the datagrams to restore the flight data to its original form. The application layer then passes the data to a stored file 78 in the storage unit 52. The functions performed by the aircraft 12 and the flight operations center 18 are similarly interchangeable when data is transferred from the flight operations center 18 to the aircraft 12.

FIG. 4 is a flowchart illustrating a method carried out by the gatelink processor 32 in the aircraft. At step 82, the gatelink processor 32 receives a weight-on-wheels interrupt which signals that the aircraft has landed, and the data transfer is initiated. The application layer 58 compresses the flight data at step 84 and encrypts the data at step 86. At step 88, the data is segmented into datagrams and UDP/IP packets are constructed. The packets are then placed in a packet queue. The packets are then ready for transmission as a fixed number of threads, corresponding to the number of cell channels 36. At step 90, the primary data thread is

started to make the initial call and open the communications channel to the flight operations center 18. A wait state at step 92 is invoked for a predetermined period of time (5 sec.) and at step 94, the processor 32 determines if any threads are active, i.e. if there are any packets that haven't been transmitted or have been transmitted and dropped. If there are no packets remaining, the method is completed at step 96. If there are packets remaining, the method enters the wait state at step 92 and subsequently determines if any threads are active at step 94.

FIG. 5 is a flowchart illustrating a method of performing the start primary data thread step 90 of FIG. 4. At step 98, the point-to-point protocol (PPP) connection is initiated for the primary data thread through one of the cell channels 36 and the gatelink session is initiated at step 100. The secondary data thread transmissions are started at step 102. At step 104, it is determined if any packets are left in the primary data thread to be transmitted. If so, the next packet in the primary data thread is transmitted at step 106. If no packets are left to transmit in the primary data thread as determined at step 104, it is determined if any of the secondary data threads are active at step 108. If so, the process returns to step 104 and repeats step 108 until no threads are active. If no threads are active, the gatelink session is ended at step 110 and the PPP connection for the primary data thread is closed at step 112. At step 114, the primary data thread step 90 is completed.

FIG. 6 is a flowchart illustrating a method of performing the start secondary data threads step 102 of FIG. 5. The method is carried out in parallel for each secondary data thread. At step 116, the thread is set to active so that the processor 32 can determine if any threads are active at step 108 of FIG. 5. The PPP connection for the secondary data thread being transmitted is initiated at step 118. At step 120, it is determined if any packets remain in the data thread. If so, the packet is transmitted at step 122. If no packets remain in the data thread, the PPP connection is closed at step 124 and the thread is set to inactive at step 126. The method is completed at step 128.

FIG. 7 is a flowchart illustrating a method of operating the gatelink processor 50 in the flight operations center 18. At step 130, a socket is opened to allow the operating system 72 in the processor 50 to receive and transport messages across the Internet 45. At step 132, the processor 50 waits for a message from the Internet 16. When a message is received, the processor 50 determines if the message is a session initialization message at step 134. If the message is a session initialization message, the processor 50 executes the session initialization process at step 136. If the message is not a session initialization message at step 134, the processor 50 determines if the message is a data message at step 138. If the message is a data message, the processor 50 executes the data message process at step 140. If the message is not a data message, the processor 50 determines if the message is an end session message at step 142. If the message is an end session message, the processor 50 executes the end session process at step 144 and then returns to step 132 to wait for additional messages..

FIG. 8 is a flowchart illustrating a method of performing the initialize session process step 136 of FIG. 7. The processor 50 allocates buffer space for subsequent data reception at step 146. The processor 50 then sends a session initialized data acknowledgment to the processor 32 at step 148. At step 150, the flow returns to step 132 of FIG. 7.

FIG. 9 is a flowchart illustrating a method of performing the data message process step 140 of FIG. 7. At step 152, the received data message is copied to a buffer and an acknowledgment of the data received is sent at step 154. At step 156, the flow returns to step 132 of FIG. 7.

FIG. 10 is a flowchart illustrating the steps included in the end session process step 144 of FIG. 7. At step 158, the checksum is computed for the received data to check the integrity of the data. The checksum is checked at step 160 and, if it is correct, the processor 50 saves the buffer to a temporary file at step 162. The processor 50 then decrypts the file at step 164 and uncompresses the file at step 166. The processor 50 sends an end session acknowledge message to the processor 32 at step 168 and at step 170, the flow returns to step 132 of FIG. 7. If the checksum is not correct, the processor 50 sends an unsuccessful end session message, which notifies the processor 32 to resend the data.

FIG. 11 is a block diagram illustrating another embodiment of the system 10 illustrated in FIG. 1. The operation of the system 10 of FIG. 11 is similar to that described in conjunction with the system 10 of FIG. 2. However, the flight data is transmitted from the cellular infrastructure 14 to the flight operations center 18 via the public-switched telephone network 172. A modem bank 174 receives the data via the PSTN 172. The data is then routed by the router 46 to the processor 50 via the network 48. The modem bank 174 can have a modem dedicated to receive data transmitted by one of the cell channels 36.

While the present invention has been described in conjunction with preferred embodiments thereof, many modifications and variations will be apparent to those of ordinary skill in the art. For example, although the system has been described hereinabove as transferring data from the aircraft, the system can also be used to transfer data to the aircraft with no modifications in the system. Also, the system may be used to transmit data while the aircraft is in flight. Furthermore, the system may be used without encryption and without data compression prior to sending data. The foregoing description and the following claims are intended to cover all such modifications and variations.

What is claimed is:

1. An aircraft data transmission system, the aircraft having a data acquisition unit, comprising:

a communications unit located in the aircraft and in communication with the data acquisition unit;

a cellular infrastructure in communication with said communications unit after the aircraft has landed, wherein the communication is initiated automatically upon landing of the aircraft; and

a data reception unit in communication with said cellular infrastructure.

2. The system of claim 1 wherein said data reception unit is in communication with said cellular infrastructure via the Internet.

3. The system of claim 1 wherein said data reception unit is in communication with said cellular infrastructure via the public switch telephone network.

4. The system of claim 1 wherein said communications unit has at least one modem in communication with said cellular infrastructure and said data reception unit has at least one modem in communication with said cellular infrastructure.

5. The system of claim 1 wherein said communications unit includes:

a processor;

a serial card in communication with said processor;

at least one cell channel in communication with said serial card; and

at least one antenna in communication with said cell channel.

6. The system of claim 1 wherein said cellular infrastructure includes:

an antenna;

a transceiver subsystem in communication with said antenna; and

a controller in communication with said transceiver subsystem.

7. The system of claim 1 wherein said data reception unit includes:

a router; and

a processor in communication with said router, said processor having a storage unit.

8. A data system for an aircraft, comprising:

a digital flight data acquisition unit in communication with at least one sensor;

a processor in communication with said digital flight data acquisition unit;

a serial card in communication with said processor; and

a plurality of cell channels in communication with said serial card, said cell channels for transmitting data via a cellular infrastructure after the aircraft has landed, wherein the communication between the cell channels and the serial card is initiated automatically upon landing of the aircraft.

9. The system of claim 8 further comprising an antenna in communication with said cell channels.

10. The system of claim 8 wherein said processor includes a personal computer.

11. The system of claim 8 wherein said processor includes an ASIC.

12. The system of claim 8 wherein said processor includes a microprocessor.

13. The system of claim 8 wherein said processor has an I/O interface in communication with said digital flight data acquisition unit.

14. An aircraft, comprising:

a digital flight data acquisition unit in communication with at least one sensor; and

a communications unit in communication with said digital flight data acquisition unit, said communications unit including:

a processor in communication with said digital flight data acquisition unit;

a serial card in communication with said processor; and

a plurality of cell channels in communication with said serial card, said cell channels for transmitting data via a cellular infrastructure after the aircraft has landed, wherein the communication between the cell channels and the serial card is initiated automatically upon landing of the aircraft.

15. An aircraft data transmission system, the aircraft having a data acquisition unit, comprising:

means for transmitting data from the data acquisition unit via a cellular infrastructure after the aircraft has landed, wherein transmission of the data is initiated automatically upon landing of the aircraft; and

means for receiving said data from said cellular infrastructure.

16. The system of claim 15 wherein said means for transmitting data includes a processor.

17. The system of claim 15 wherein said means for receiving data includes a processor.

18. A method of transmitting aircraft flight data from an aircraft, comprising:

receiving flight data from a data acquisition unit;

transmitting said flight data via a cellular communications infrastructure after the aircraft has landed, wherein the cellular communications infrastructure is accessed automatically upon landing of the aircraft; and

receiving said transmitted flight data.

19. A computer-implemented method of transmitting aircraft flight data from an aircraft, comprising:

receiving flight data from a digital flight data acquisition unit;

processing said flight data to prepare said data for transmission; and

transmitting said processed data via a cellular infrastructure after the aircraft has landed, wherein the cellular infrastructure is accessed automatically upon landing of the aircraft.

20. The method of claim 19 further comprising receiving said transmitted data at a flight operations center.

21. The method of claim 20 further comprising receiving said transmitted data and transmitting said received data via the Internet before receiving said transmitted data at a flight operations center.

22. The method of claim 20 further comprising receiving said transmitted data and transmitting said received data via the public-switched telephone network before receiving said transmitted data at a flight operations center.

23. The method of claim 19 wherein processing said flight data includes:

compressing said flight data;

encrypting said flight data;

segmenting said flight data; and

constructing packets of data from said segmented flight data.

24. The method of claim 19 wherein receiving said transmitted data includes:

acknowledging receipt of said transmitted data;

reassembling said received data;

decrypting said reassembled data;

uncompressing said decrypted data; and

storing said uncompressed data.

25. A computer-implemented method of transmitting aircraft flight data from an aircraft, comprising:

receiving flight data from a digital flight data acquisition unit;

processing said flight data to prepare said data for transmission; and

transmitting said processed data via a cellular infrastructure after the aircraft has landed, wherein processing said flight data includes:

receiving a weight-on-wheels signal;

initiating a data transfer;

compressing said flight data;

encrypting said compressed data;

creating a packet queue;

starting a primary data thread;

waiting a predetermined period of time;

determining if any threads are active;

repeating, when threads are active, the steps of waiting a predetermined period of time and determining if any threads are active; and

exiting processing said flight data when no threads are active.

26. The method of claim 25 wherein starting a primary data thread includes:

initiating a PPP connection;

initiating a transfer session;

starting at least one secondary data thread;

determining if data remains in the primary data thread;

sending said data when data remains in the primary data thread;

determining if data threads are active when no data remains in the primary data thread;

repeating, when said threads are active, the step of determining if data remains in the primary data thread;

ending said session when no threads are active;

closing said PPP connection; and

exiting starting a primary data thread.

27. The method of claim 26 wherein starting at least one secondary data thread includes:

(a) setting the secondary data thread to active;

(b) initiating a PPP connection;

(c) determining if data remains in the secondary data thread;

(d) sending a data packet when data remains;

(e) repeating step c when data remains;

(f) closing said PPP connection when no data remains;

(g) setting the secondary data thread to inactive;

(h) exiting starting at least one secondary data thread; and

(i) repeating steps a through h for each secondary data thread.

28. The method of claim 27 wherein repeating steps a through h includes repeating steps a through h in parallel for each said secondary data thread.

29. A computer-implemented method of transmitting aircraft flight data from an aircraft, comprising:

receiving flight data from a digital flight data acquisition unit;

processing said flight data to prepare said data for transmission; and

transmitting said processed data via a cellular infrastructure after the aircraft has landed; and

receiving said transmitted data at a flight operations center, wherein receiving said transmitted data includes:

creating a socket;

receiving a message;

determining if said message is an initialization message;

initiating a session when said message is an initialization message;

determining if said message is a data message when said message is not an initialization message;

processing said message when said message is a data message;

determining if said message is an end session when said message is not a data message;

processing said message when said message is an end session; and

repeating, when said message is not an end session message, the step of receiving a message.

30. The method of claim 29 wherein initializing a session includes:

allocating buffer space;

sending an initiation session acknowledgment; and

returning to receiving a message.

31. The method of claim 29 wherein processing said message when said message is a data message includes:

copying said message to a buffer;

sending a data message acknowledgment; and

returning to receiving a message.

32. The method of claim 29 wherein processing said message when said message is not an end session includes:

computing a checksum;

determining if said checksum is valid;

saving a buffer to a temporary file;

decrypting said temporary file;

uncompressing said temporary file;

sending an end session acknowledgment; and

returning to receiving a message.

33. A computer readable medium having stored thereon instructions which when executed by a processor, cause the processor to perform the steps of:

receiving flight data from a digital flight data acquisition unit in an aircraft;

processing said flight data to prepare said data for transmission; and

transmitting said processed data via a cellular infrastructure when said aircraft has landed, wherein the cellular infrastructure is accessed automatically upon landing of the aircraft.

* * * * *

PATENT APPLICATION TRANSMITTAL LETTER
(Large Entity)

Docket No.
TET-1689

TO THE ASSISTANT COMMISSIONER FOR PATENTS

Transmitted herewith for filing under 35 U.S.C. 111 and 37 C.F.R. 1.53 is the patent application of:

John F. Grabowsky and David Ray Stevens

For: AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM

Enclosed are:

- ☒ Certificate of Mailing with Express Mail Mailing Label No. EI859386855US
- ☒ 11 sheets of drawings.
- ☐ A certified copy of a application.
- ☒ Declaration ☒ Signed. ☐ Unsigned.
- ☒ Power of Attorney
- ☒ Information Disclosure Statement
- ☐ Preliminary Amendment
- ☒ Other: Assignment and Recordation Sheet

CLAIMS AS FILED

For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	33	- 20 =	13	x $22.00	$286.00
Indep. Claims	7	- 3 =	4	x $82.00	$328.00
Multiple Dependent Claims (check if applicable) ☐					$0.00
				BASIC FEE	$790.00
				TOTAL FILING FEE	$1,404.00

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☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. 01-0840 as described below. A duplicate copy of this sheet is enclosed.
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- ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).

Dated: July 30, 1998

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Invention: AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM

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POWER OF ATTORNEY

Docket No.
TET-1689

Name of Applicant: **Teledyne Industries, Inc.**
Address of Applicant: **2049 Century Park East**
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Title: **AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM**

Serial No., If Any:
Filed:

TO THE ASSISTANT COMMISSIONER FOR PATENTS

The Assistant Commissioner for Patents
Washington, D.C. 20231

Honorable Sir:
I hereby appoint:

Robert J. Pugh, Reg. No. 36,895 and Patrick J. Viccaro, Reg. No. 27,842

as principal attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

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Dated: July 30, 1998

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AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM

INVENTORS
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David Ray Stevens

CROSS-REFERENCE TO RELATED APPLICATIONS

(Not Applicable)

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

(Not Applicable)

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is directed generally to an aircraft flight data acquisition and transmission system and, more particularly, to an on-board cellular data transmission system.

Description of the Background

It is common for aircraft to generate records of data relating to flight and performance parameters for each flight of the aircraft. The data typically relate to parameters such as air speed, altitude, vertical acceleration, heading, time, etc. The data are utilized in the event of an accident or a near-accident and to assist in maintenance of the aircraft by detecting faulty components or gradual deterioration of a system or component, to assist in reviewing crew performance, and to assist in logistical planning activities such as scheduling and routing.

Aircraft data are typically gathered by a digital flight data acquisition unit (DFDAU). The DFDAU typically stores the data on magnetic or magnetic-optical media. When the aircraft lands, ground personnel board the aircraft, remove the media, and mail the media to a flight operations center (FOC). The manual removal and posting of the data adds a

significant labor cost, yields less than desirable data delivery reliability, and results in a significant time delay before the data are useful for analysis.

It is known to use radio frequency (RF) transmissions to transmit data relating to an aircraft. Such teachings, however, require substantial investments to construct the RF transmission systems required for such a system to work. Furthermore, it is very expensive to create redundancy in such a system.

It is also known to transmit data relating to an aircraft via a telephone system located in a terminal. Such a system, however, requires that the aircraft be docked at the gate before transmission begins, thereby resulting in a substantial delay in the transmission. Furthermore, such a system requires an added step of transmitting the data from the aircraft to the terminal telephone system, increasing the cost of installing, operating, and maintaining such a system.

Thus, there is a need for an aircraft data transmission system that automatically transfers flight data from an aircraft to a flight operations center with little or no human involvement and which relies on a reliable wireless delivery system.

SUMMARY OF THE INVENTION

The present invention is directed to an aircraft data transmission system used with an aircraft having a data acquisition unit. The system includes a communications unit located in the aircraft and in communication with the data acquisition unit. The system also includes a cellular infrastructure in communication with the data communications unit after the aircraft has landed. The system further includes a data reception unit in communication with the cellular infrastructure.

The present invention represents a substantial advance over prior aircraft data acquisition and transmission systems. For example, the present invention has the advantage that it requires little expense to implement because it uses well-known technology and the

cellular infrastructure which is already in place. The present invention also has the advantage that it can transmit data over multiple parallel channels to achieve the necessary transmission bandwidth and achieve a low data transmission time. The present invention has the further advantage that it does not require a dedicated data link between the aircraft and the flight operations center and/or an airport terminal.

BRIEF DESCRIPTION OF THE DRAWING

For the present invention to be clearly understood and readily practiced, the present invention will be described in conjunction with the following figures, wherein:

FIG. 1 illustrates an aircraft data acquisition and transmission system;

FIG. 2 is a block diagram illustrating a more detailed embodiment of the system illustrated in FIG. 1;

FIG. 3 is a block diagram illustrating data flow through the system illustrated in FIG. 2;

FIG. 4 is a flowchart illustrating a method carried out by the gatelink processor in the aircraft;

FIG. 5 is a flowchart illustrating a method of performing the start primary data thread step of FIG. 4;

FIG. 6 is a flowchart illustrating a method of performing the start secondary data threads step of FIG. 5;

FIG. 7 is a flowchart illustrating a method of operating the gatelink processor in the flight operations center;

FIG. 8 is a flowchart illustrating a method of performing the initialize session process step of FIG. 7;

FIG. 9 is a flowchart illustrating a method of performing the data message process step of FIG. 7;

FIG. 10 is a flowchart illustrating a method of performing the end session process step of FIG. 7; and

FIG. 11 is a block diagram illustrating another embodiment of the system illustrated in FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

It is to be understood that the figures and descriptions of the present invention have been simplified to illustrate elements that are relevant for a clear understanding of the present invention, while eliminating, for purposes of clarity, other elements found in a typical communications system. It can be recognized that other elements are desirable and/or required to implement a device incorporating the present invention. For example, the details of the cellular communications infrastructure, the Internet, and the public-switched telephone network are not disclosed. However, because such elements are well known in the art, and because they do not facilitate a better understanding of the present invention, a discussion of such elements is not provided herein.

FIG. 1 illustrates an aircraft data acquisition and transmission system 10. An aircraft 12, which has stored flight data, is illustrated after landing. The aircraft 12 transmits flight data as cellular communications signals to a cellular infrastructure 14. The cellular infrastructure 14 acts as a communications channel to the communications medium 16. A flight operations center 18 is connected to the medium 16 by any conventional connectivity medium such as, for example, a leased line. Once the cellular connections are made via the medium 16 data can flow bidirectionally from or to the aircraft.

FIG. 2 is a block diagram illustrating a more detailed embodiment of the system 10 illustrated in FIG. 1. The aircraft 12 includes a data system 19 having a data acquisition unit 20. The data acquisition unit 20 includes a digital flight data acquisition unit (DFDAU) processor 22, which includes a storage media for storing flight data in a digital format. The

DFDAU processor 22 receives signals from sensors 24 which sense parameters such as air speed, altitude, vertical acceleration, heading, time, etc. The flight data are transferred to a communications unit 26 via a bus 28. The bus 28 is connected to an I/O interface 30 in the communications unit 26. The I/O interface 30 can be a standard bus interface such as, for example, an ARINC 429 bus interface.

The I/O interface 30 is connected to a gatelink processor 32. The processor 32 can be a general purpose processor such as a personal computer, a microprocessor such as an Intel Pentium® processor, or a special purpose processor such as an application specific integrated circuit (ASIC) designed to operate in the system 10. The processor 32 is responsive to a weight-on-wheels signal, which acts as an interrupt signal to signal the processor 32 to initiate transmission or reception of the data when the aircraft 12 has landed. Upon receipt of the weight-on-wheels signal from the landing gear of the aircraft 12, the processor 32 prepares the flight data for transmission and transmits the data to a multi-port serial card 34. Each I/O port of the card 34 is attached to a cell channel which can open, sustain, and close a physical, over-the-air channel to the cellular infrastructure 14. The cell channels 36 can transmit simultaneously and can thus transmit data in parallel. Each cell channel 36 is connected to an antenna matching network and a post amplifier (not shown). An antenna 38 is installed in the aircraft 12 so as to optimize free space radiation to the cellular infrastructure 14.

The data are transmitted over a cellular airlink using the physical layer modulation of the cellular infrastructure 14. The cellular infrastructure 14 includes an antenna 40, which is within free-space radiating range of the aircraft 12. The antenna 40 is connected to a base station transceiver subsystem 42. The subsystem 42 is connected to a base station controller 44 which has a direct connection via a router (not shown) to the Internet 45. The flight data are transmitted via the Internet 45 to the flight operations center 18.

A local router 46 in a data reception unit 47 of the flight operations center 18 is connected to the Internet 45, such as via a connection to the backbone of the Internet 45. The router 46 connects a local area network 48 to the Internet 45. The local area network can be of any type of network such as, for example, a token ring network, an ATM network, or an Ethernet network. A gatelink processor 50 is connected to the network 48 and receives the flight data for storage in an attached storage unit 52. The storage unit 52 can be any type of unit capable of storing data such as, for example, a disk array or a tape drive. The storage unit 52 makes the flight data available to data analysis applications 54 which can analyze and/or report the flight data to a user.

Data transfer can also occur from the flight operations center 18 to the aircraft 12. The data are transmitted via the Internet 45 and the cellular infrastructure 14 and received by the antenna 38. The serial card 34 receives the data from the cell channels 36 and the processor 32 outputs the data, via the I/O interface 30, to avionics 55.

FIG. 3 is a block diagram illustrating data flow through the system 10 illustrated in FIG. 2. The flight data is stored in the DFDAU processor 22 as a stored file 56. An application layer 58 of an operating system 60 of the gatelink processor 32 compresses, encrypts, and segments the data. The operating system 60 can be any type of operating system suitable such as, for example, UNIX. A typical stored file may be compressed from approximately 40 Mbytes to approximately 4 Mbytes. Compression may be done by any compression method such as, for example, the method embodied in the PKZIP® compression utility, manufactured by PKWARE, Inc. Encryption can be accomplished using any suitable asymmetric (public key) or symmetric encryption method such as, for example, the method embodied in Data Encryption Software (DES), manufactured by American Software Engineering or the methods in the RC2, RC4, or RC5 encryption software manufactured by RSA Data Security, Inc. During segmentation individual datagrams of, for example, 1024 bytes are formed and indexed for subsequent reassembly.

The operating system 60 passes the datagrams to a network layer 62 which constructs UDP/IP packets from the datagrams by adding message headers to the datagrams. The network layer 62 then routes the packets to one of up to 16 peer-to-peer protocol (PPP) threads running within the operating system 60 at a data link layer interface 64. The PPP threads convey the packets to the multi-port serial card 34 for transmission to the backbone 66 of the Internet 45 via the cell channels 36 to the cellular infrastructure 14. The packets are received from the Internet 45 by the local router 46 in the flight operations center 18. The network layer 62 receives acknowledgments of received packets from the gatelink processor 50 in the flight operations center 18. The network layer 62 also re-queues packets that are dropped before reaching the gatelink processor 50.

The local router 46 in the flight operations center 18 receives the packets and routes them to the gatelink processor 50. A local network interface 68 receives the packets and a data link layer interface 70 of an operating system 72 passes the packets to a network layer 74 of the operating system 72. The operating system 72 can be any type of suitable operating system such as, for example, UNIX. The network layer 74 sends acknowledgments of successful packet deliveries to the gatelink processor 32. The network layer 74 also removes the UDP/IP headers and passes the datagrams to an application layer 76. The application layer 76 reassembles, decrypts, and uncompresses the datagrams to restore the flight data to its original form. The application layer then passes the data to a stored file 78 in the storage unit 52. The functions performed by the aircraft 12 and the flight operations center 18 are similarly interchangeable when data is transferred from the flight operations center 18 to the aircraft 12.

FIG. 4 is a flowchart illustrating a method carried out by the gatelink processor 32 in the aircraft. At step 82, the gatelink processor 32 receives a weight-on-wheels interrupt which signals that the aircraft has landed, and the data transfer is initiated. The application layer 58 compresses the flight data at step 84 and encrypts the data at step 86. At step 88,

the data is segmented into datagrams and UDP/IP packets are constructed. The packets are then placed in a packet queue. The packets are then ready for transmission as a fixed number of threads, corresponding to the number of cell channels 36. At step 90, the primary data thread is started to make the initial call and open the communications channel to the flight operations center 18. A wait state at step 92 is invoked for a predetermined period of time (5 sec.) and at step 94, the processor 32 determines if any threads are active, i.e. if there are any packets that haven't been transmitted or have been transmitted and dropped. If there are no packets remaining, the method is completed at step 96. If there are packets remaining, the method enters the wait state at step 92 and subsequently determines if any threads are active at step 94.

FIG. 5 is a flowchart illustrating a method of performing the start primary data thread step 90 of FIG. 4. At step 98, the point-to-point protocol (PPP) connection is initiated for the primary data thread through one of the cell channels 36 and the gatelink session is initiated at step 100. The secondary data thread transmissions are started at step 102. At step 104, it is determined if any packets are left in the primary data thread to be transmitted. If so, the next packet in the primary data thread is transmitted at step 106. If no packets are left to transmit in the primary data thread as determined at step 104, it is determined if any of the secondary data threads are active at step 108. If so, the process returns to step 104 and repeats step 108 until no threads are active. If no threads are active, the gatelink session is ended at step 110 and the PPP connection for the primary data thread is closed at step 112. At step 114, the primary data thread step 90 is completed.

FIG. 6 is a flowchart illustrating a method of performing the start secondary data threads step 102 of FIG. 5. The method is carried out in parallel for each secondary data thread. At step 116, the thread is set to active so that the processor 32 can determine if any threads are active at step 108 of FIG. 5. The PPP connection for the secondary data thread being transmitted is initiated at step 118. At step 120, it is determined if any packets remain

in the data thread. If so, the packet is transmitted at step 122. If no packets remain in the data thread, the PPP connection is closed at step 124 and the thread is set to inactive at step 126. The method is completed at step 128.

FIG. 7 is a flowchart illustrating a method of operating the gatelink processor 50 in the flight operations center 18. At step 130, a socket is opened to allow the operating system 72 in the processor 50 to receive and transport messages across the Internet 45. At step 132, the processor 50 waits for a message from the Internet ~~16~~ 45. When a message is received, the processor 50 determines if the message is a session initiatialization message at step 134. If the message is a session initialization message, the processor 50 executes the session initiatialization process at step 136. If the message is not a session initiatialization message at step 134, the processor 50 determines if the message is a data message at step 138. If the message is a data message, the processor 50 executes the data message process at step 140. If the message is not a data message, the processor 50 determines if the message is an end session message at step 142. If the message is an end session message, the processor 50 executes the end session process at step 144 and then returns to step 132 to wait for additional messages..

FIG. 8 is a flowchart illustrating a method of performing the initialize session process step 136 of FIG. 7. The processor 50 allocates buffer space for subsequent data reception at step 146. The processor 50 then sends a session initialized data acknowledgment to the processor 32 at step 148. At step 150, the flow returns to step 132 of FIG. 7.

FIG. 9 is a flowchart illustrating a method of performing the data message process step 140 of FIG. 7. At step 152, the received data message is copied to a buffer and an acknowledgment of the data received is sent at step 154. At step 156, the flow returns to step 132 of FIG. 7.

FIG. 10 is a flowchart illustrating the steps included in the end session process step 144 of FIG. 7. At step 158, the checksum is computed for the received data to check the

integrity of the data. The checksum is checked at step 160 and, if it is correct, the processor 50 saves the buffer to a temporary file at step 162. The processor 50 then decrypts the file at step 164 and uncompresses the file at step 166. The processor 50 sends an end session acknowledge message to the processor 32 at step 168 and at step 170, the flow returns to step 132 of FIG. 7. If the checksum is not correct, the processor 50 sends an unsuccessful end session message, which notifies the processor 32 to resend the data.

FIG. 11 is a block diagram illustrating another embodiment of the system 10 illustrated in FIG. 1. The operation of the system 10 of FIG. 11 is similar to that described in conjunction with the system 10 of FIG. 2. However, the flight data is transmitted from the cellular infrastructure 14 to the flight operations center 18 via the public-switched telephone network 172. A modem bank 174 receives the data via the PSTN 172. The data is then routed by the router 46 to the processor 50 via the network 48. The modem bank 174 can have a modem dedicated to receive data transmitted by one of the cell channels 36.

While the present invention has been described in conjunction with preferred embodiments thereof, many modifications and variations will be apparent to those of ordinary skill in the art. For example, although the system has been described hereinabove as transferring data from the aircraft, the system can also be used to transfer data to the aircraft with no modifications in the system. Also, the system may be used to transmit data while the aircraft is in flight. Furthermore, the system may be used without encryption and without data compression prior to sending data. The foregoing description and the following claims are intended to cover all such modifications and variations.

CLAIMS

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1. An aircraft data transmission system, the aircraft having a data acquisition unit, comprising:

a communications unit located in the aircraft and in communication with the data acquisition unit;

a cellular infrastructure in communication with said communications unit after the aircraft has landed; and

a data reception unit in communication with said cellular infrastructure.

2. The system of claim 1 wherein said data reception unit is in communication with said cellular infrastructure via the Internet.

3. The system of claim 1 wherein said data reception unit is in communication with said cellular infrastructure via the public switch telephone network.

4. The system of claim 1 wherein said communications unit has at least one modem in communication with said cellular infrastructure and said data reception unit has at least one modem in communication with said cellular infrastructure.

5. The system of claim 1 wherein said communications unit includes:

a processor;

a serial card in communication with said processor;

at least one cell channel in communication with said serial card; and

at least one antenna in communication with said cell channel.

6. The system of claim 1 wherein said cellular infrastructure includes:

an antenna;

a transceiver subsystem in communication with said antenna; and

a controller in communication with said transceiver subsystem.

7. The system of claim 1 wherein said data reception unit includes:

a router; and

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11 13

a processor in communication with said router, said processor having a storage unit.

8. A data system for an aircraft, comprising:

a flight data acquisition unit in communication with at least one sensor;

a processor in communication with said digital flight data acquisition unit;

a serial card in communication with said processor; and

a plurality of cell channels in communication with said serial card, said cell channels for transmitting data via a cellular infrastructure after the aircraft has landed.

9. The system of claim 8 further comprising an antenna in communication with said cell channels.

10. The system of claim 8 wherein said processor includes a personal computer.

11. The system of claim 8 wherein said processor includes an ASIC.

12. The system of claim 8 wherein said processor includes a microprocessor.

13. The system of claim 8 wherein said processor has an I/O interface in communication with said digital flight data acquisition unit.

14. An aircraft, comprising:

a digital flight data acquisition unit in communication with at least one sensor; and

a communications unit in communication with said digital flight data acquisition unit, said communications unit including:

a processor in communication with said digital flight data acquisition unit;

a serial card in communication with said processor; and

a plurality of cell channels in communication with said serial card, said cell channels for transmitting data via a cellular infrastructure after the aircraft has landed.

15. An aircraft data transmission system, the aircraft having a data acquisition unit, comprising:

means for transmitting data from the data acquisition unit via a cellular infrastructure after the aircraft has landed; and

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means for receiving said data from said cellular infrastructure.

16. The system of claim 15 wherein said means for sending data includes a processor.

17. The system of claim 15 wherein said means for receiving data includes a processor.

18. A method of transmitting aircraft flight data from an aircraft, comprising:

receiving flight data from a data acquisition unit;

transmitting said flight data via a cellular communications infrastructure after the aircraft has landed; and

receiving said transmitted flight data.

19. A computer-implemented method of transmitting aircraft flight data from an aircraft, comprising:

receiving flight data from a digital flight data acquisition unit;

processing said flight data to prepare said data for transmission; and

transmitting said processed data via a cellular infrastructure after the aircraft has landed.

20. The method of claim 19 further comprising receiving said transmitted data at a flight operations center.

21. The method of claim 20 further comprising receiving said transmitted data and transmitting said received data via the Internet before receiving said transmitted data at a flight operations center.

22. The method of claim 20 further comprising receiving said transmitted data and transmitting said received data via the public-switched telephone network before receiving said transmitted data at a flight operations center.

23. The method of claim 19 wherein processing said flight data includes:

compressing said flight data;

encrypting said flight data;

segmenting said flight data; and

constructing packets of data from said segmented flight data.

24. The method of claim 19 wherein receiving said transmitted data includes:

acknowledging receipt of said transmitted data;

reassembling said received data;

decrypting said reassembled data;

uncompressing said decrypted data; and

storing said uncompressed data.

25. The method of claim 19 wherein processing said flight data includes:

receiving a weight-on-wheels signal;

initiating a data transfer;

compressing said flight data;

encrypting said compressed data;

creating a packet queue;

starting a primary data thread;

waiting a predetermined period of time;

determining if any threads are active;

repeating, when threads are active, the steps of waiting a predetermined period of time and determining if any threads are active; and

exiting processing said flight data when no threads are active.

26. The method of claim 25 wherein starting a primary data thread includes:

initiating a PPP connection;

initiating a transfer session;

starting at least one secondary data thread;

determining if data remains in the primary data thread;

sending said data when data remains in the primary data thread;

determining if data threads are active when no data remains in the primary data thread;

repeating, when said threads are active, the step of determining if data remains in the primary data thread;

ending said session when no threads are active;

closing said PPP connection; and

exiting starting a primary data thread.

27. The method of claim 26 wherein starting at least one secondary data thread includes:

(a) setting the secondary data thread to active;

(b) initiating a PPP connection;

(c) determining if data remains in the secondary data thread;

(d) sending a data packet when data remains;

(e) repeating step c when data remains;

(f) closing said PPP connection when no data remains;

(g) setting the secondary data thread to inactive;

(h) exiting starting at least one secondary data thread; and

(i) repeating steps a through h for each secondary data thread.

28. The method of claim 27 wherein repeating steps a through h includes repeating steps a through h in parallel for each said secondary data thread.

29. The method of claim 20 wherein receiving said transmitted data includes:

creating a socket;

receiving a message;

determining if said message is an initialization message;

initiating a session when said message is an initialization message;

determining if said message is a data message when said message is not an initialization message;

processing said message when said message is a data message;

determining if said message is an end session when said message is not a data message;

processing said message when said message is an end session; and

repeating, when said message is not an end session message, the step of receiving a message.

30. The method of claim 29 wherein initializing a session includes:

allocating buffer space;

sending an initiation session acknowledgment; and

returning to receiving a message.

31. The method of claim 29 wherein processing said message when said message is a data message includes:

copying said message to a buffer;

sending a data message acknowledgment; and

returning to receiving a message.

32. The method of claim 29 wherein processing said message when said message is not an end session includes:

computing a checksum;

determining if said checksum is valid;

saving a buffer to a temporary file;

decrypting said temporary file;

uncompressing said temporary file;

sending an end session acknowledgment; and

returning to receiving a message.

33. A computer readable medium having stored thereon instructions which when executed by a processor, cause the processor to perform the steps of:

receiving flight data from a digital flight data acquisition unit in an aircraft;

processing said flight data to prepare said data for transmission; and

transmitting said processed data via a cellular infrastructure when said aircraft has landed.

ABSTRACT OF THE DISCLOSURE

An aircraft data transmission system used with an aircraft having a data acquisition unit. The system includes a communications unit located in the aircraft and in communication with the data acquisition unit. The system also includes a cellular infrastructure in communication with the data communications unit after the aircraft has landed. The system further includes a data reception unit in communication with the cellular infrastructure.

DOCKET NO. TET-1689

DECLARATION

INVENTORSHIP IDENTIFICATION

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor *(if only one name is listed below)* or an original, first and joint inventor *(if plural names are listed below)* of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM

SPECIFICATION IDENTIFICATION

the specification of which:

(a) ☒ is attached hereto.

(b) ☐ was filed on _____, as ☐ Serial No. 0/
☐ and was amended on _ *(if applicable).*

(c) ☐ was described and claimed in PCT International Application No. __ filed on _____
☐ and was amended on _____. *(if applicable).*

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Application Number	Country or PCT	Date Of Filing (Day, Month, Year)	Priority not Claimed	Certified Copy Attached?
			☐	☐ YES NO ☐

CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S) UNDER *35* U.S.C. § 119(e)

Provisional Application Number	Filing Date

DOCKET NO. TET-1889

CLAIM FOR BENEFIT OF EARLIER US/PCT APPLICATION(S) UNDER 35 U.S.C. 120
(All Foreign Application(S), *If Any*, Filed More Than 12 Months
(6 Months For Design) Prior To This U.S. Application)

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or 365(c) PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56, which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application.

U.S Parent Application No.	PCT Parent Application No.	Date Of Filing (Day, Month, Year)	Parent Patent No. (*if applicable*)

DECLARATION

I hereby declare that my presentation of this paper constitutes a certification under 37 C.F.R § 10.18, which provides, in part, that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and that further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application and any patent issuing therefrom.

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DOCKET NO. TET-1689

SIGNATURE(S)

Inventor(s)

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(GIVEN NAME)	*(MIDDLE INITIAL OR NAME)*	*FAMILY (OR LAST NAME)*

Inventor's signature:
Date: Country of Citizenship:
Residence:
Post Office Address:

☐ **Signature** by administrator(trix), or legal representative for deceased or incapacitated inventor. *Number of pages added* _____.

☐ **Signature** for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. *Number of pages added* _____.

☐ Added page for **signature** by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 CFR 1.47) *Number of pages added* _____

☐ Authorization of attorney(s) to accept and follow instructions from representative.

☒ This declaration ends with this page.

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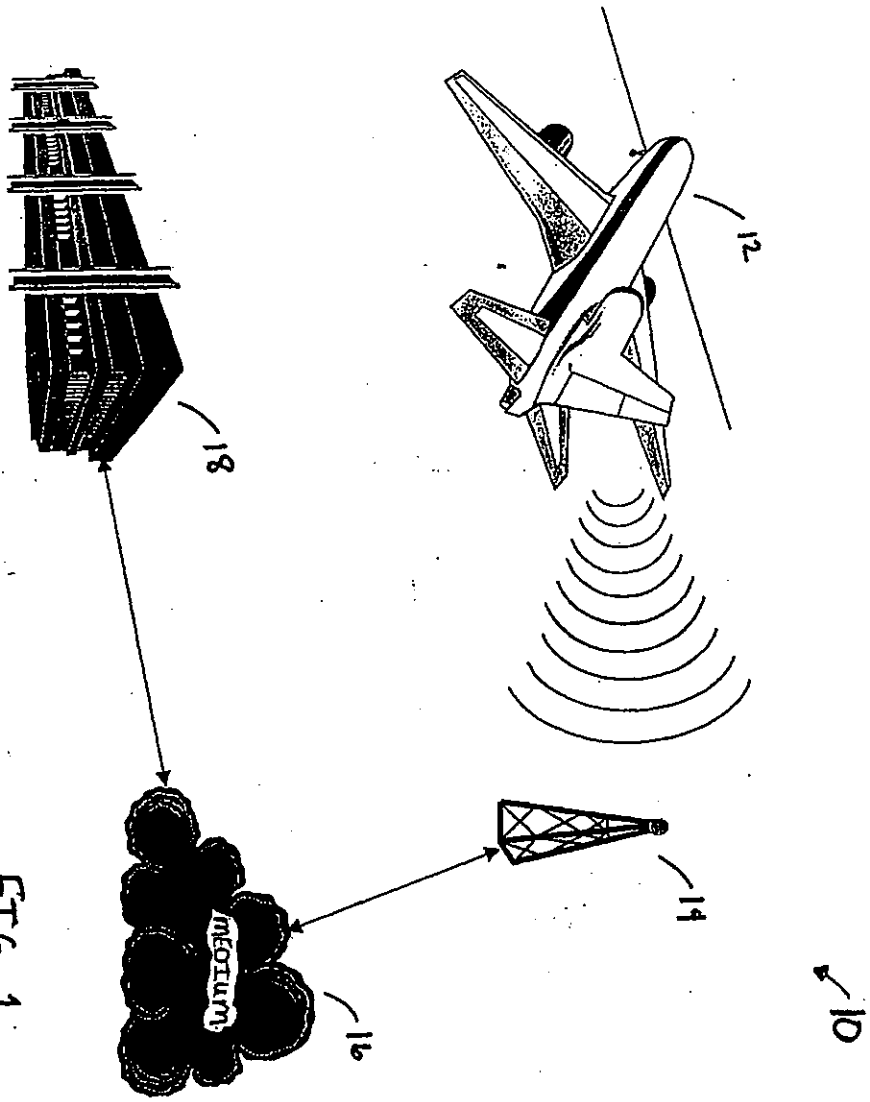

FIG. 1

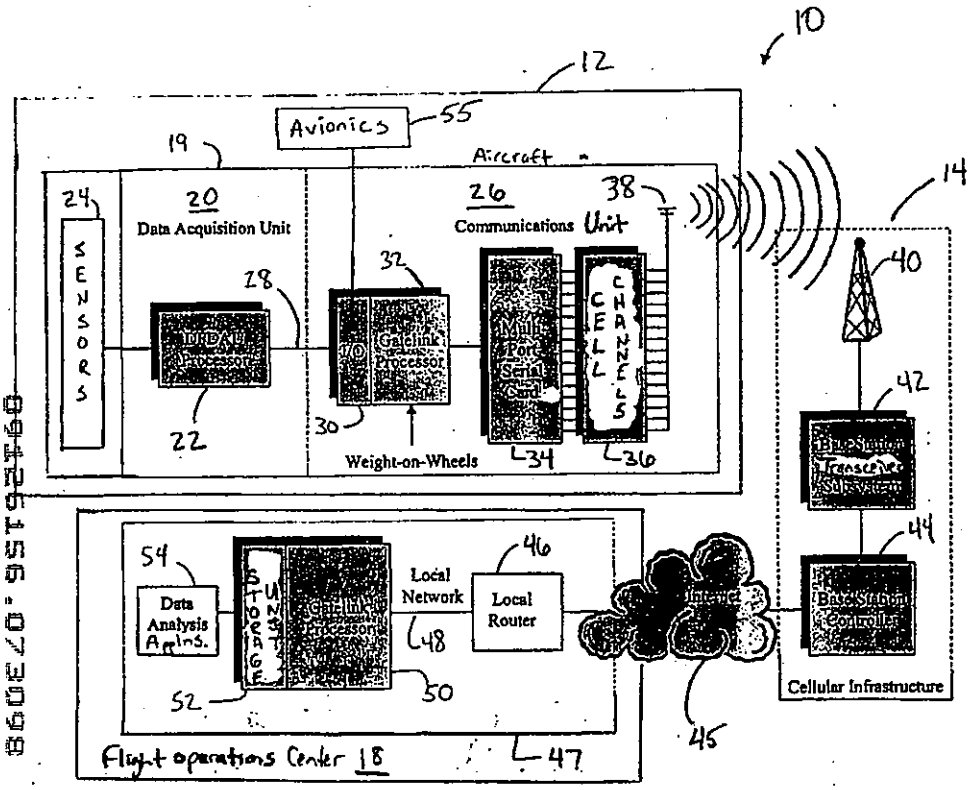

FIG. 2

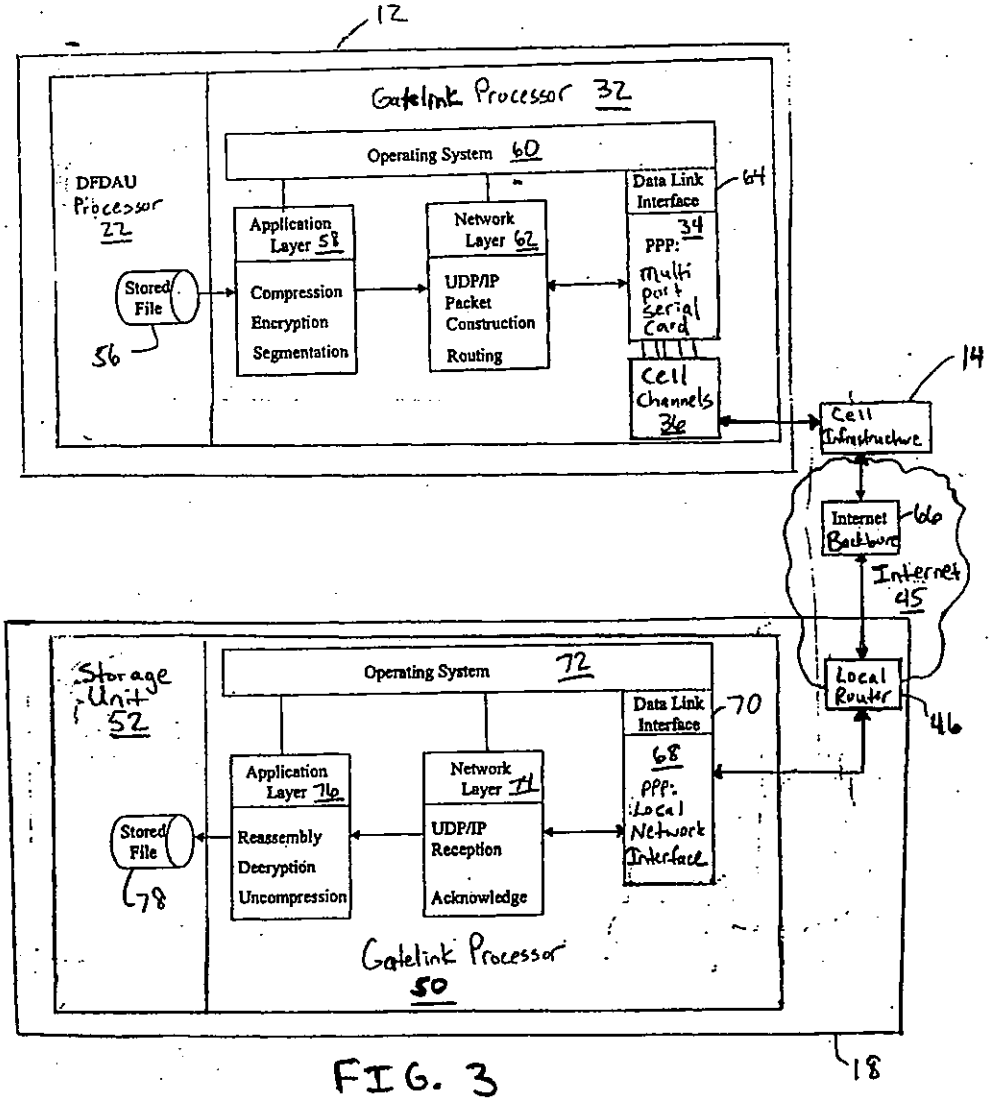

FIG. 3

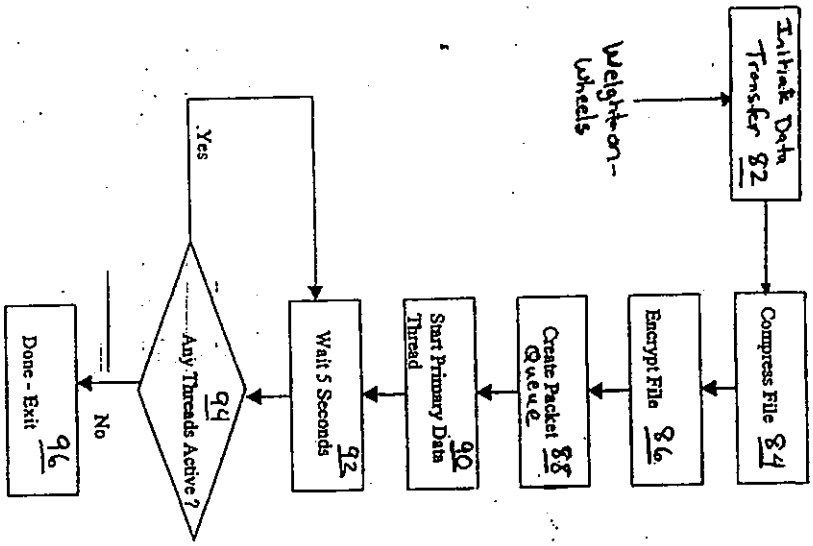

Fig. 4

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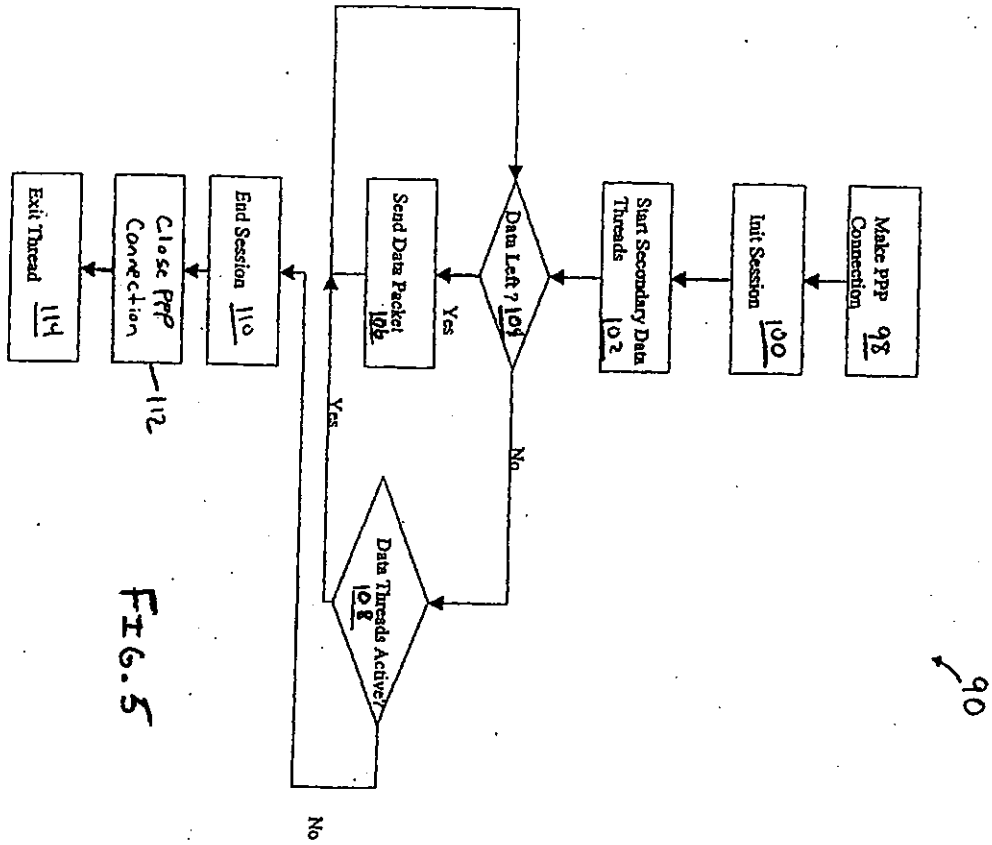

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FIG. 5

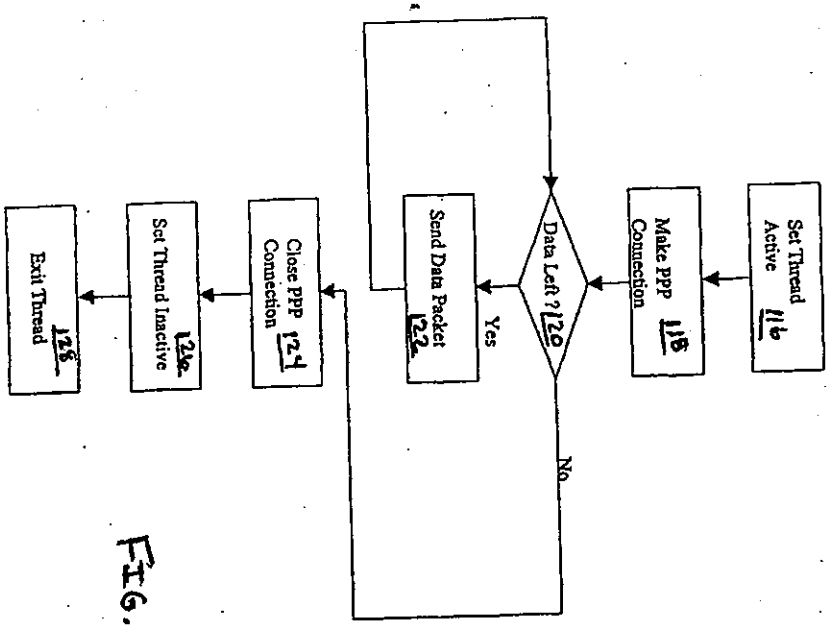
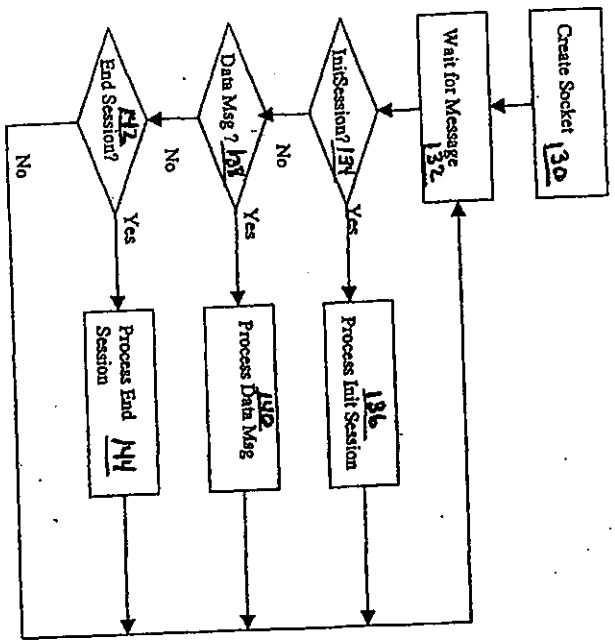


FIG. 6

FIG. 7



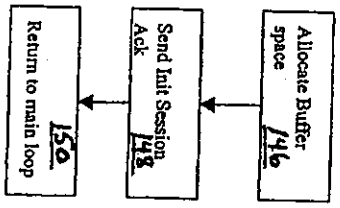


FIG. 8

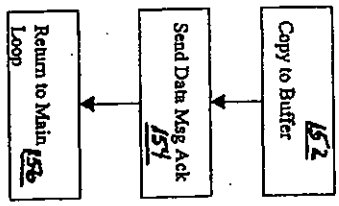


FIG. 9

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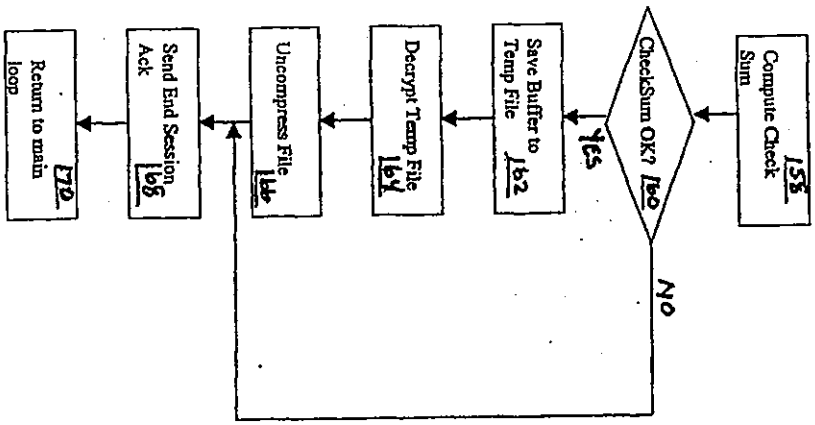

FIG. 10

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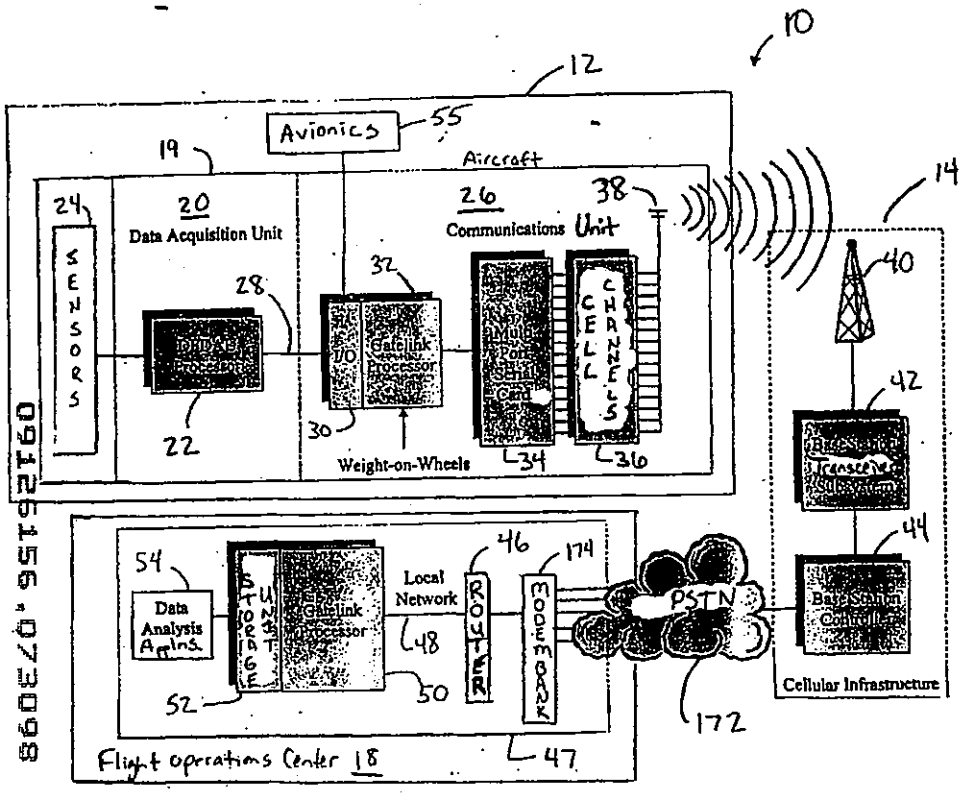


FIG. 11

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Art Unit:
Examiner:

2/air attach
C.R
1-11-99

In re application of	:	AIRCRAFT FLIGHT DATA ACQUISITION AND TRANSMISSION SYSTEM
Grabowsky et al.	:	
Serial No.:	:	Group No.
Filed:	:	

INFORMATION DISCLOSURE STATEMENT

Pittsburgh, Pennsylvania 15222

July30, 1998

Assistant Commissioner for Patents

Washington, DC 20231

Sir:

Applicants, in accordance with their duty of disclosure pursuant to 37 C.F.R. § 1.56, hereby advise the United States Patent and Trademark Office of the references listed on the accompanying form PTO-1449 *Information Disclosure Citation.* A copy of each of the references cited therein is herewith enclosed.

"Express Mail" mailing label number EI859386855US

Date of Deposit July 30, 1998

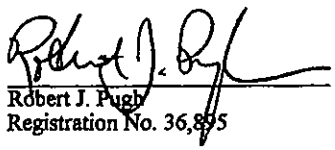
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner of Patents, Washington, DC 20231

Susan M. Malyszka

PI-244640.01

Applicants note that although the cited references may be relevant to the examination of the above-referenced application, under 37 C.F.R. § 1.97(h), the filing of this *Information Disclosure Statement* "shall not be construed to be an admission that the information cited in the statement is, or is considered to be, material to patentability as defined in § 1.56(b)."

Respectfully submitted,



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UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/126,156	07/30/98	GRABOWSKY J	TET-1689

PM82/1001

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EXAMINER	
GIBSON,E	
ART UNIT	PAPER NUMBER
3661	3

DATE MAILED: 10/01/99

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

PTO-90C (Rev. 2/96) 1- File Copy

Office Action Summary	Application No. 09/128,156	Applicant(s) Grabowsky et al.
	Examiner Eric M. Gibson	Group Art Unit 3661

☒ Responsive to communication(s) filed on *Jul 30, 1998*

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *1-33* is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) *1-24 and 33* is/are rejected.

☒ Claim(s) *25-32* is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☒ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐approved ☐disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 2

☐ Interview Summary, PTO-413

☒ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

— SEE OFFICE ACTION ON THE FOLLOWING PAGES —

U. S. Patent and Trademark Office
PTO-326 (Rev. 9-95) Office Action Summary Part of Paper No. 3

DETAILED ACTION

Specification

The disclosure is objected to because of the following informalities: On page 9, line 7, the Internet is referred to as 16, it should be 45. Figure 8 is described as a flowchart of step 136, but is incorrectly labeled 134 in the drawings.

Appropriate correction is required.

Claim Rejections - 35 U.S.C. § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 8- 13, and 16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 8 and 13 recite the limitation "said digital flight data acquisition unit" in lines 4 and 14, respectively. There is insufficient antecedent basis for this limitation in the claim. Specifically, there is a lack of antecedent basis for the term "digital" as it appears in both claims.

Claims 9-12 depend on claim 8 which is rejected as explained above.

Claim 16 recites the limitation "said means for sending data" in line 2. There is insufficient antecedent basis for this limitation in the claim. This can be corrected by changing "sending" to "transmitting" as used in claim 15.

Claim Rejections - 35 U.S.C. § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 4, 7-8, 10, 12, 14-20 are rejected under 35 U.S.C. 102(b) as being anticipated by Bailey et al. Bailey et al. discloses a data acquisition unit in communication with sensors that transmits vehicle data via a communications unit to a remote data reception unit using a cellular infrastructure. Transmission of data by the communications unit is accomplished through a personal computer microprocessor by using a cellular modem using a cellular digital packet data network. The data is transmitted through a serial interface over cellular channels in the infrastructure to a router in the data reception unit. Aircraft are considered to be "vehicles."

Claim Rejections - 35 U.S.C. § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 2-3, and 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bailey et al. in view of Cleave. Bailey et al. discloses the invention as explained in the previous rejections. Bailey et al. does not teach using the Internet or public switched telephone network (PSTN) to receive the data from the cellular infrastructure at the data reception unit. Cleave teaches in column 4, lines 44-47, the use of the Internet or PSTN coupled to the gateway to receive the information at the data reception unit in a data communications system. It would have been obvious to one of ordinary skill in the art, at the time of the invention, to provide the invention of Bailey et al. with a connection to the Internet or PSTN in order to receive the data from the cellular infrastructure.

Claims 5- 6, and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bailey et al. Bailey et al. discloses the invention as explained in the previous rejections. Bailey et al. does not teach a cellular infrastructure with an antenna, transceiver subsystem, and controller. It is well known in the art that in order for a cellular communications system to operate it must contain these items. It would have been obvious to one of ordinary skill in the art, at the time of

invention , to include in the invention of Bailey et al. the components of a cellular system that are well known in the art in order for it to function properly.

Claims 11 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bailey et al. Bailey et al. discloses the invention as explained in the previous rejections. Bailey et al. does not teach that the processor may be an application specific integrated circuit (ASIC) or that the processor has an I/O interface. It is well know in the art to use an ASIC for specific applications. It is also well known in the art to use an I/O interface connected to a processor to allow for the exchange of data with the processor. It would have been obvious to one of ordinary skill in the art, at the time of invention, to include in the invention of Bailey et al. the features of a processor that are well known in the art in order to allow better operation.

Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bailey et al. in view of Krenzel. Bailey et al. teaches the use of a cellular digital packet data network in the invention as previously explained. Bailey et al. does not teach the use of compression or encryption in the data network. Krenzel teaches compression/uncompression of data in column 3, lines 30-41, for the use in a data communication system. It would have been obvious to one of ordinary skill in the art, at the time of the invention, to include in the invention of Bailey et al. the data compression/uncompression as taught by Krenzel in order to reduce the file size of the data needed to be transmitted, increasing the speed of transmission. Encryption, and subsequent decryption at the receiving end, is well known in the art to provide additional security for the transmission of data via a wireless system. It would have been obvious to one of ordinary skill

in the art, at the time of the invention, to include data encryption and decryption in the invention of Bailey et al. in order to provide additional security over a wireless system.

Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bailey et al in view of Steiner and in further view of Krenzel. Bailey et al. teaches the invention as explained in the previous claims including the use of disk drives for data storage. Bailey et al. in combination with Krenzel teach the invention as explained in the rejection of claim 23. The combination of Bailey et al. and Krenzel do not teach acknowledging receipt of data. Steiner teaches the acknowledgment of receipt of data in column 9, lines 16-17, in a data packet communication system. It would have been obvious to one of ordinary skill in the art, at the time of invention, to include in the combination of Bailey et al. and Krenzel the data acknowledgment receipt of Steiner in order to ensure proper delivery of data through the system.

Claim 33 is rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Bailey et al. Bailey et al. does not teach writing a computer program to a suitable medium to implement the steps of data exchange when the program is executed by the processor. The writing of programs stored on computer readable media to implement specific functions is well know in the art. Several programs exist that are well know in the art of data transmission, refer to Winslow, column 4, lines 20-29 for examples of data transmitting programs that are well known in the art.

Allowable Subject Matter

Claims 25-32 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Kaman teaches remote vehicle data collection using data packet technology over a cellular network and using PSTN and Internet resources to collect data at a central station. McCoy teaches a remote data collection device with cellular communication means to send data to a communications site. Levine teaches the transmission of aircraft flight data over a wireless communications system to a central ground based processing station. Averbuch et al. teaches a radio communication system utilizing a data router, data packets, PSTN, and Internet Protocol destination addresses. Fraker et al. teaches a vehicle data communication system which communicates data to a central location using cellular technology and the steps of transmission of data. Westerlage et al. teaches data messaging in a communications network with remote units. Barbiaux et al. teaches a system wherein a vehicle communicates data to a remotely located base station via a rf communication means. Zinser, Jr. teaches information communication between an aircraft and a ground unit utilizing cellular technology for the

transmission of data. Podowski et al. teaches a system of data communication using cellular transmission technology for aircraft. Severwright teaches a telecommunications system for an aircraft that communicates with a ground station. Winslow is used as a reference to the known computer readable applications used for the transmission of data between a remote unit and a command center as applicable in the data communications art.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eric M. Gibson whose telephone number is (703) 306-4545.

WILLIAM A. CUCHLINSKI, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 3600

emg

September 27, 1999

Notice of References Cited

Application No.	Applicant(s)		
09/128,156	Grabowsky et al.		
Examiner		Group Art Unit	Page 1 of 2
Erlo M. Gibson		3661	

U.S. PATENT DOCUMENTS

		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS
	A	5,124,915	6/23/92	Krenzel	702	5
	B	5,793,813	8/11/98	Cleave	375	259
	C	4,939,652	7/3/90	Steiner	701	35
	D	5,844,473	12/1/98	Kaman	340	439
	E	5,283,767	2/1/94	McCoy	367	4
	F	5,890,079	3/30/99	Levine	701	14
	G	5,901,142	5/4/99	Averbuch et al.	370	329
	H	5,919,239	7/6/99	Fraker et al.	701	35
	I	5,826,195	10/20/98	Westerlage et al.	455	456
	J	4,804,937	2/14/89	Barbiaux et al.	340	459
	K	5,440,544	8/8/95	Zinser, Jr.	370	319
	L	5,524,272	6/4/96	Podowski et al.	455	3.2
	M	5,926,759	7/20/99	Severwright	455	431

FOREIGN PATENT DOCUMENTS

		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
	N						
	O						
	P						
	Q						
	R						
	S						
	T						

NON-PATENT DOCUMENTS

		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	U		
	V		
	W		
	X		

U. S. Patent and Trademark Office
PTO-892 (Rev. 9-95)

Notice of References Cited

Part of Paper No. 3

Notice of References Cited	Application No. 09/128,156	Applicant(s) Grabowsky et al.	
	Examiner Eric M. Gibson	Group Art Unit 3661	Page 2 of 2

U.S. PATENT DOCUMENTS

	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS
A	5,852,825	12/22/98	Winslow	707	8
B					
C					
D					
E					
F					
G					
H					
I					
J					
K					
L					
M					

FOREIGN PATENT DOCUMENTS

	DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
N						
O						
P						
Q						
R						
S						
T						

NON-PATENT DOCUMENTS

	DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
U		
V		
W		
X		

Form PTO-1449

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

INFORMATION DISCLOSURE
STATEMENT BY APPLICANT

(Use several sheets if necessary)

Atty. Docket No.	Serial No.
TET-1689	09/126,156
Applicant: Grabowsky et al.	
Filing Date: 7/30/98	Group: 3661

U. S. PATENT DOCUMENTS

Examiner Initial		Document Number	Issue Date	Patentee	Class	Sub-Class	Filing Date
EWS		4,729,102	3/1/88	Miller, Jr., et al.			
EWS		4,926,331	5/15/90	Windle et al.			
EWS		5,185,700	2/9/93	Bezos et al.			
EWS		5,400,018	3/21/95	Scholl et al.			
EWS		5,550,738	8/27/96	Bailey et al.			
EWS		5,680,328	10/21/97	Skorupski et al.			
EWS		Re 35,590	8/19/97	Bezos et al.			

FOREIGN PATENT OR PUBLISHED FOREIGN PATENT APPLICATION

Examiner Initial		Document Number	Public. Date	Country or Patent Office	Class	Sub-Class	Transl Y	Transl N

OTHER DOCUMENTS
(Including Author, Title, Date, Relevant Pages, Place of Publication)

Examiner	Date Considered
Eric M. Gibson	9/22/99

EXAMINER: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication

PI-244637.01

Part of #2

FORM PTO 948 (REV. 11-97) U.S. DEPARTMENT OF COMMERCE-Patent and Trademark Office Application No. 166156

NOTICE OF DRAFTPERSON'S PATENT DRAWING REVIEW

The drawing filed (insert date) 7/30/98

A. _____ not objected to by the Draftperson under 37 CFR 1.84 or 1.152.

B. X objected to by the Draftperson under 37 CFR 1.84 or 1.152 as indicated below. The Examiner will require submission of new, corrected drawings whe necessary. Corrected drawings must be submitted according to the instructions on the back of this notice.

1. DRAWINGS. 37 CFR 1.84(a): Acceptable categories of drawings:
Black ink. Color.
_____ Color drawing are not acceptable until petition is granted.
Fig.(s) _____
_____ Pencil and non black ink is not permitted. Fig(s) _____

2. PHOTOGRAPHS. 37 CFR 1.84(b)
_____ Photographs are not acceptable until petition is granted.
_____ 3 full-tone sets are required. Fig(s) _____
_____ Photographs not properly mounted (must brystol board or photographic double-weight paper). Fig(s) _____
_____ Poor quality (half-tone). Fig(s) _____

3. TYPE OF PAPER. 37 CFR 1.84(e)
_____ Paper not flexible, strong, white and durable.
Fig.(s) _____
_____ Erasures, alterations, overwritings, interlineations, solids, copy machine marks not acceptable. (too thin)
_____ Mylar, vellum paper is not acceptable (too thin).
Fig(s) _____

4. SIZE OF PAPER. 37 CFR 1.84(F): Acceptable sizes:
_____ 21.0 cm by 29.7 cm (DIN size A4)
_____ 21.6 cm by 27.9 cm (8 1/2 x 11 inches)
_____ All drawings sheets not the same size.
Sheet(s) _____

5. MARGINS. 37 CFR 1.84(g): Acceptable margins:
Top 2.5 cm Left 2.5 cm Right 1.5 cm Bottom 1.0 cm
SIZE: A4 Size
Top 2.5 cm Left 2.5 cm Right 1.5 cm Bottom 1.0 cm
SIZE: 8 1/2 x 11
_____ Margins not acceptable. Fig(s) 2, 3, 5, 6, 11
_____ Top (T) X Left (L)
X Right (R) _____ Bottom (B)

6. VIEWS. CFR 1.84(h)
REMINDER: Specification may require revision to correspond to drawing changes.
_____ Views connected by projection lines or lead lines.
Fig.(s) _____
Partial views. 37 CFR 1.84(h)(2)
_____ Brackets needed to show figure as one entity.
Fig.(s) _____
_____ Views not labeled separately or properly.
Fig.(s) _____
_____ Enlarged view not labeled separately or properly.
Fig.(s) _____

7. SECTIONAL VIEWS. 37 CFR 1.84(h)(3)
_____ Hatching not indicated for sectional portions of an object.
Fig.(s) _____
_____ Sectional designation should be noted with Arabic or Roman numbers. Fig.(s) _____

8. ARRANGEMENT OF VIEWS. 37 CFR 1.84(i)
_____ Words do not appear on a horizontal, left-to-right fashion when page is either upright or turned, so that the top becomes the right side, except for graphs. Fig.(s) _____
_____ Views not on the same plane on drawing sheet. Fig.(s) _____

9. SCALE. 37 CFR 1.84(k)
_____ Scale not large enough to show mechanism without crowding when drawing is reduced in size to two-thirds in reproduction.
Fig.(s) _____

10. CHARACTER OF LINES, NUMBERS, & LETTERS. 37 CFR 1.84(l)
X Lines, numbers & letters not uniformly thick and well defined, clean, durable and black (poor line quality).
Fig.(s) 1-11

11. SHADING. 37 CFR 1.84(m)
_____ Solid black areas pale. Fig.(s) _____
_____ Solid black shading not permitted. Fig.(s) _____
_____ Shade lines, pale, rough and blurred. Fig.(s)

12. NUMBERS, LETTERS, & REFERENCE CHARACTERS. 37 CFR 1.48(p)
_____ Numbers and reference characters not plain and legible.
Fig.(s) _____
_____ Figure legends are poor. Fig.(s) _____
_____ Numbers and reference characters not oriented in the same direction as the view. 37 CFR 1.84(p)(3) Fig.(s) _____
_____ English alphabet not used. 37 CFR 1.84(p)(3) Fig.(s) _____
_____ Numbers, letters and reference characters must be at least .32 cm (1/8 inch) in height. 37 CFR 1.84(p)(3) Fig.(s) _____

13. LEAD LINES. 37 CFR 1.84(q)
_____ Lead lines cross each other. Fig.(s) _____
_____ Lead lines missing. Fig.(s) _____

14. NUMBERING OF SHEETS OF DRAWINGS. 37 CFR 1.48(t)
_____ Sheets not numbered consecutively, and in Ababic numerals beginning with number 1. Fig.(s) _____

15. NUMBERING OF VIEWS. 37 CFR 1.84(u)
_____ Views not numbered consecutively, and in Abrabic numerals, beginning with number 1. Fig.(s) _____

16. CORRECTIONS. 37 CFR 1.84(w)
_____ Corrections not made from PTO-948 dated _____

17. DESIGN DRAWINGS. 37 CFR 1.152
_____ Surface shading shown not appropriate. Fig.(s) _____
_____ Solid black shading not used for color contrast.
Fig.(s) _____

COMMENTS

REVIEWER A.D DATE 8/14/98 TELEPHONE NO. 703 308 6404

ATTACHMENT TO PAPER NO. 3

PTO COPY

#4

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))	Docket No. TET-1689

In Re Application Of: **Grabowsky, et al.**

Serial No.	Filing Date	Examiner	Group Art Unit
09/126,156	July 30, 1998	Gibson, E.	3661

Title: **CELLULAR FLIGHT DATA RECORDER**

Address to:
Assistant Commissioner for Patents
Washington, D.C. 20231

37 CFR 1.97(b)

1. ☐ The Information Disclosure Statement submitted herewith is being filed within three months of the filing of a national application; within three months of the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; or before the mailing date of a first Office Action on the merits, whichever event occurs last.

37 CFR 1.97(c)

2. ☒ The Information Disclosure Statement submitted herewith is being filed after three months of the filing of a national application, or the date of entry of the national stage as set forth in 37 CFR 1.491 in an international application; or after the mailing date of a first Office Action on the merits, whichever occurred last but before the mailing date of either:

   1. a Final Action under 37 CFR 1.113, or
   2. a Notice of Allowance under 37 CFR 1.311,

   whichever occurs first.

Also submitted herewith is:

☒ a certification as specified in 37 CFR 1.97(e);

OR

☐ the fee set forth in 37 CFR 1.17(p) for submission of an Information Disclosure Statement under 37 CFR 1.97(c).

11/18/1999 STEFERR0 00000080 010840 09126156
01 FC:126 240.00 CH

 P10A/REV01

GP3661

TRANSMITTAL OF INFORMATION DISCLOSURE STATEMENT (Under 37 CFR 1.97(b) or 1.97(c))	Docket No. TET-1689

In Re Application Of: Grabowsky, et al.

Serial No.	Filing Date	Examiner	Group Art Unit
09/126,156	July 30, 1998	Gibson, E.	3661

Title: CELLULAR FLIGHT DATA RECORDER

Payment of Fee
(Only complete if Applicant elects to pay the fee set forth in 37 CFR 1.17(p))

☐ A check in the amount of is attached.

☒ The Assistant Commissioner is hereby authorized to charge and credit Deposit Account No. 01-0840 as described below. A duplicate copy of this sheet is enclosed.

- ☒ Charge the amount of 240.00
- ☒ Credit any overpayment.
- ☒ Charge any additional fee required.

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P10A/REV01

STATEMENT UNDER 37 CFR 1.97(e) ACCOMPANYING INFORMATION DISCLOSURE STATEMENT	Docket No. TET-1689

In Re Application Of: Grabowsky et al.

Serial No.	Filing Date	Examiner	Group Art Unit
09/126,156	July 30, 1998	Gibson, E.	3661

Invention: **CELLULAR FLIGHT DATA RECORDER**

TO THE ASSISTANT COMMISSIONER FOR PATENTS:

This is a statement under the provisions of 37 CFR 1.97(e) in the above-identified application.

Check applicable statement herebelow:

Statement Under 37 CFR 1.97(e)(1)

☒ Each item of information contained in the accompanying information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement.

Statement Under 37 CFR 1.97(e)(2)

☐ No item of information contained in the accompanying information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned person, after making reasonable inquiry, no item of information contained in the accompanying information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement.

Robert J. Pugh — Dated: 11/12/99

Signature

Robert J. Pugh, Registration No. 36,895
Allegheny Teledyne Incorporated
1000 Six PPG Place
Pittsburgh, PA 15222

I certify that this document is being deposited on 11-12-99 with the U.S. Postal Service as first class mail under 37 C.F.R. 1.8 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Signature of Person Mailing Correspondence

Susan M. Lloyd

Typed or Printed Name of Person Mailing Correspondence

cc:

P10C/REV01